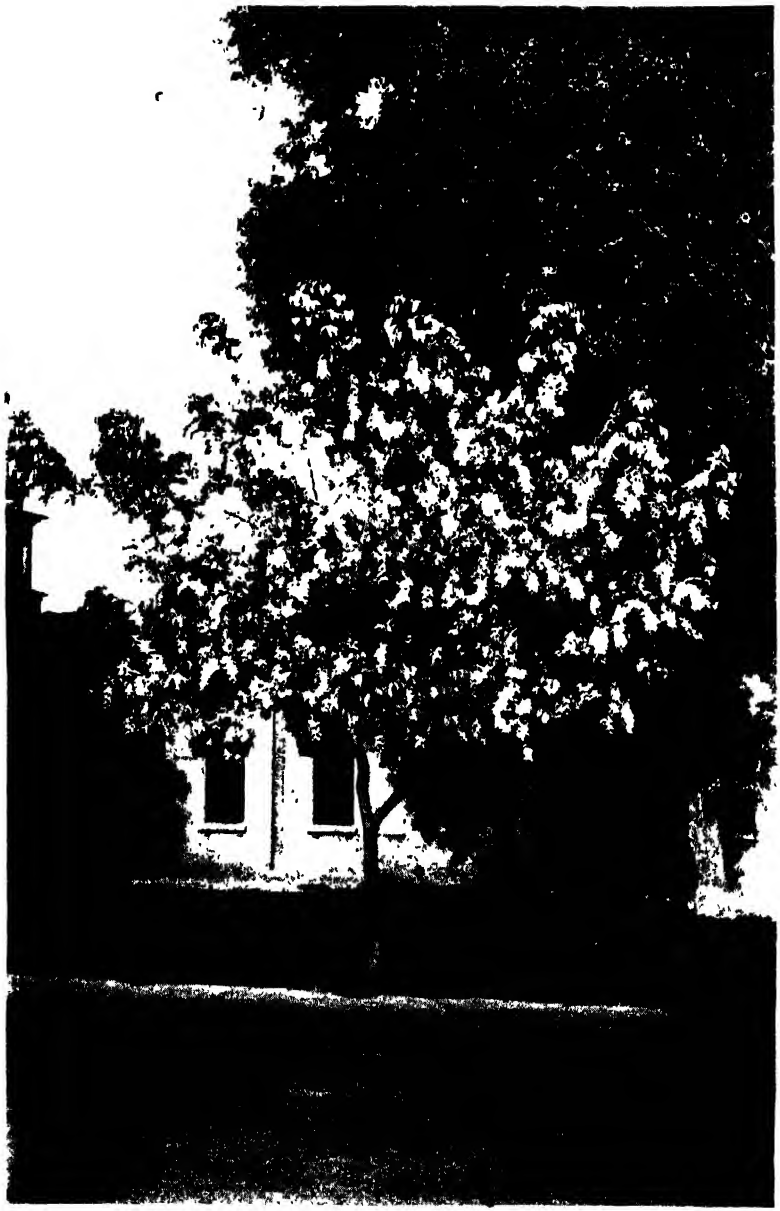
BEEKEEPING IN INDIA



Indian Laburnum in bloom. Honeybees collect nectar and pollen from its flowers.

BEEKEEPING IN INDIA

By

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INDIAN COUNCIL OF AGRICULTURAL RESEARCH

NEW DELHI

FIRST PRINTED DECEMBER, 1962

Chief Editor: PREM NATH
Assistant Editor: KRISHAN KUMAR

PRINTED BY S. N. GUHA RAY
AT SREE SARASWATY PRESS LIMITED, CALCUTTA-9

PREFACE

BEEKEEPING has been practised in India from time immemorial. The earliest mention of it is found in the Vedas and the Ramayana. Since then, the history of beekeeping can be followed with but little change in the management methods and little improvement in the techniques of keeping them. For the past 2,000 years, if not more, bees have been known to be kept in log and pot hives and in the recesses of the walls for the production of honey. These methods are still in vogue in some parts of the country and no marked improvement has been effected in them. How wasteful and crude some of these methods were, is illustrated by the process of extracting honey by squeezing combs. This entailed the destruction of the bees which collected the nectar and the combs that contained honey. If this destruction were not wrought, the same colonies could have been made to yield honey year after year.

Scientific beekeeping is new in India. After the improvement in the methods of beekeeping resulting from new knowledge of the biology and behaviour of the honeybee and the discovery of the principles of movable frame-hives, honey extractor, and the smoker in the West in the second half of the 19th century, efforts were made to introduce these improvements in this country also. Such attempts have a long and chequered history beginning with the introduction of movable frame-hive in Bengal in 1882 and in the Punjab in 1883-84. But one of the causes of the failure of such attempts to popularise scientific methods of beekeeping on a large scale or to bring out an appreciable improvement in the old methods is the paucity of suitable literature conceived and written in the context of our known and felt inadequacy.

As in other branches, what we lack in the field of beekeeping is technical competence and practical knowledge. Success in beekeeping is largely a question of proper understanding of the biology and the behaviour of the honeybees and their proper management including knowledge of their diseases and enemies and latest equipment for handling them. An attempt has been made to put into this volume authentic and up-to-date information on all aspects of beekeeping in a concise and popular style. It is intended

to serve as a handy reference and guide book for students of agriculture, extension workers and all those who are interested in beekeeping either as a hobby or as a profession.

In writing this book, help has been received from a number of persons. My thanks are due to Dr. E. S. Narayanan, Head of the Division of Entomology, Indian Agricultural Research Institute, for giving me valuable suggestions in writing this book. I am also thankful to late Dr. D. Chatterjee, Superintendent, Botanical Gardens, Calcutta, for checking the botanical terms used in the book.

The book has been edited by Shri Prem Nath, former Chief Editor and Production Specialist, Indian Council of Agricultural Research, with the assistance of Shri M. L. Madan, Sub-Editor. Its production aspects have been looked after by Shri Krishan Kumar, Assistant Editor, in collaboration with Sarvshri Inderjit Lall, J. B. Bali and Kailash Nath. The cover design and other art work of the book has been prepared by Shri N. S. Bisht with the assistance of Shri O. P. Gulhati. I am thankful to all these officers of the Council for the assistance given by them in the production of this book.

Ludhiana, Punjab SARDAR SINGH

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IMPORTANCE OF BEEKEEPING

THE honeybee and the fruits of its toils have been familiar to all from prehistoric times. It is one of the few insects that are directly beneficial to man. No wonder one comes across a lot of folk-lore praising the honeybee's diligence and usefulness. These winged creatures find mention in the Vedas and the Ramayana, the Book of Proverbs, the Quran and many other ancient books. Figures and carvings of the honeybee, its combs and hives are found on tombs, coffins, crowns, maces of kings and coins of ancient and modern empires.

In ancient times honey and beeswax were accepted by Governments in payment of taxes and tributes. A jar of honey is a welcome gift which would sweeten existing relations and is a good inauguration of new friendships. Many religions speak highly of honey and beeswax and enjoin on their followers the use of these two commodities in various rites performed during festivals and on many occasions in the life of an individual. Honey is also prized as food and medicine; and the uses of beeswax are many and varied.

A honeybee colony has a fascination of its own and naturalists, poets, and thinkers alike have revelled in the pleasant art of solving its mysteries. It will not be far wrong to say that the honeybee is one of the most studied creatures and has numerous books written about itself. Some writers have admired honeybees for their industry, unity, self-sacrifice, calmness of spirit, toleration, equitable division of labour in their colonies and spirit of social service. Others believe that by working with them one acquires happiness, needed diversion, develops a philosophy of self-sufficiency, self-reliance, self-preservation and learns coordination of thought. The economically minded have cultured them for honey and beeswax. Beekeeping has been mastered so well that a colony of bees yielded over 2,100 lb. of honey in South Africa. The trait of honeybees to visit and pollinate blossoms has been explored for pollinating large orchards and big acreages of vegetables, clovers, oilseeds and other crops by transferring in wire gauze cages enormous numbers of bees from one area to another.

Honeybees have been used as a weapon of war through the ages and as recently as in World War I infuriated swarms were used to hamper the advance of enemy forces in Belgium. In this country, many a political meeting has ended in pandemonium after a stone has been thrown by a mischievous opponent in a colony of wild bees hanging from a branch of a nearby tree. The dreaded bee-sting, however, has the mysterious quality of healing muscular and nervous pains and aches of sciatica, rheumatism and arthritis. Beekeepers generally do not suffer from such ailments.

Since ancient times honeybees have been kept in a crude manner in India, as in other countries of the world. After the improvement in the methods of beekeeping in the West in the second half of the nineteenth century, with the discovery of the principles of movable frame hive (in 1851 by the Revd, L. L. Langstroth), honey extractor (in 1865 by Major Hruschka) and the smoker (in 1870 by Moses Quinby), efforts were made to introduce these innovations in this country. Such attempts have a long and chequered history, the salient features of which are outlined here. First attempts to keep bees in movable frame hives were made in 1882 in Bengal and in 1883 and 1884 in the Punjab but with little success. In 1883 the Government of India published the information on beekeeping collected from the provinces under the title: *A Collection of Papers on Beekeeping in India*. A year later John Douglas, an employee of the Telegraph Department, Calcutta, published *A Handbook of Beekeeping in India*. This book is a record of his own experiences in keeping the Indian honeybee (*Apis indica* F.) in modern hives. Later the work was taken up by the then Imperial Entomologist in 1907 at Pusa and it continued up to 1919. Besides publishing a few papers, Bulletin No. 46 entitled *Beekeeping* by C. C. Ghosh was issued. This provided useful information on the subject. At the same time Sir Louis Dane in the Punjab aroused interest in beekeeping and as a result one Lt. F. S. Cousins was employed as apiarist and the Punjab Beekeepers' Association with its headquarters at Simla was formed. *A Guide for Beekeeping* was published in 1916. In South India, the Revd Newton trained several beekeepers during 1911-17 and devised a hive (named after him) which is in common use to the present day for keeping in the plains variety of the Indian bee. Travancore State took up work in 1917 and Mysore in 1925.

The recommendation of the Royal Commission on Agriculture (1928) for developing cottage industries gave a fillip to beekeeping and Madras also took up the work in right earnest in 1931, Punjab in 1933, Coorg in 1934 and U. P. in 1938. Other provinces and States followed suit but no mentionable progress appears to have been made there. Beekeepers of India organised themselves into an All-India Beekeepers' Association during the winter of 1938-39. The Association publishes the *Indian Bee Journal* and organises annual conferences and exhibitions at various centres in the country. There are State and District beekeepers' associations affiliated to it. The Indian Council of Agricultural Research coordinates the activities of workers doing research in beekeeping. The Council established a Central Beekeeping Research Station in the Punjab in 1945 and six years later at Coimbatore in Madras.

Beekeeping is an ideal hobby for it entails outdoor work, does not require much time, is not costly and the job is both interesting and instructive. Moreover the returns in the form of money and mental satisfaction are gratifying. As a cottage industry, it is truly a second string to any one's bow. It helps in increasing the yield of crops through pollination. In short, beekeeping is a paying pastime. Commercially, it has been an outstanding success in the U.S.A., Canada, Australia and New Zealand, but in India attempts so far made at commercial beekeeping have been few and far between and, therefore, no opinion can be expressed on its feasibility in this country. It may be said, however, that with greater experience gained by individual beekeepers their activities will increase gradually until beekeeping becomes their main occupation. In the context of our Five-Year Plans and Community Development Projects, honeybees are certainly an asset. They help in increasing crop yields through pollination, and gather nectar.

The honeybees have established an enviable record in some countries of the West. For example, in 1949, the U.S.A. produced 23,00,000 lb. of honey and 60,00,000 lb. of beeswax worth over Rs. 15 crores from about 54,66,000 colonies of bees owned by 5,00,000 beekeepers. In 1948, Canada produced 4,50,00,000 lb. of honey and 6,66,000 lb. of beeswax worth over Rs. 7 crores from 5,70,000 colonies owned by 32,000 beekeepers. In India, it is estimated that 64,00,000 lb. of honey and about 1,10,000 lb. of beeswax

are produced annually from the three species of bees. Its total value is Rs. 35,00,000. Surely, there is much leeway to be made up.

The economics of small-scale beekeeping has been worked out in Madras and the Punjab. Ramachandran states in *Beekeeping in South India* that accurate records were kept for 11 colonies of *Apis indica*, plains variety bees during 1932-33. Eleven swarms valued at Rs. 77·00 were raised from these colonies. Honey extracted from 11 colonies was 117 lb. 3 oz. valued at Rs. 146·49 at Rs. 1·25 per lb. Thus a gross income of Rs. 223·44 from 11 colonies was worked out. On the expenditure side the out-of-pocket expenses were Rs. 88·00 for 22 hives at Rs. 4·00 each, Rs. 10·00 for the honey extractor and an estimated Rs. 22·00 as the cost of collecting the swarms, a total outlay of Rs. 120·00. Thus the beekeeper saved more than Rs. 100·00 net.

In 1942, Gobind Ram, a beekeeper of Kangra in the Punjab gave detailed accounts of his beekeeping venture in the *Indian Bee Journal*. He began with one colony in 1937, which grew to four in 1938, six in 1940 and 11 in 1941. His original investment on equipment and the like was not even Rs. 50·00, but materials, hired labour, purchased bees, sugar, comb foundation for bees, cost Rs. 142·48, the excess expenditure having been met from the sale of honey. He extracted 290 lb. of honey in four years from 1938 to 1941 and sold honey at 75 nP. a pound through the Government apiary. Including some miscellaneous receipts his total income came to Rs. 189·19. The estimated value of the assets at the end of 1941 (raw materials at cost and appliances and bees at market value) was Rs. 151·81. His total income worked out at Rs. 341·00 and left a net saving (over the five years' working) of Rs. 198·52. On a cash investment of Rs. 50·00 his net profit was about Rs. 200·00, that is, four times the investment and his investment had increased to Rs. 151·81, three times the original.

Some preliminary investigations on the economics of migratory beekeeping carried out at the Central Beekeeping Research Station in the Punjab show that colonies taken from Katrain to Nagrota (both in Kangra District) gave a net income of Rs. 18·88 per colony compared to Rs. 5·94 per colony from colonies kept throughout the year at Katrain.

CHAPTER 2

THE HONEYBEE

In common with other insects the honeybee has a body divided into three distinct parts, namely, head, thorax and abdomen; a pair of antennae rising from the head; three pairs of jointed thoracic legs; two pairs of wings. Again like other insects the honeybee passes through intermediate forms from embryo to adulthood. Of about 9,00,000 known species of insects, there are about 20,000 different kinds of bees of which honeybees contribute only four species. The following illustrates the position of honeybees in the Animal Kingdom:

Kingdom	Animal
Phylum	Arthropoda
Class	Hexapoda or Insecta
Order	Hymenoptera
Family	Apidae
Genus	*Apis*
Species	(i) *dorsata* (ii) *florea* (iii) *indica* (iv) *mellifera*

External Anatomy. The honeybee has a hard external skeleton which protects the soft organs inside. Sensory in function, the head region consists of a pair of large compound eyes and three simple eyes (ocelli), a pair of feelers (antennae), a pair of hard jaws (mandibles) and a sucking tongue covered with sheaths. The thoracic region which is the seat of locomotion has two pairs of transparent wings (which fasten together in flight with the help of hooks) and three pairs of modified legs. The abdominal region, housing vital internal organs, consists of hooplike segments, with the sting at the tip of it (Fig. 1).

Internal Anatomy. Inside a bee's body are found all the organs and systems as are found in a human body. They perform almost the same functions. The digestive tract consists of the mouth, pharynx (a muscular pump), oesophagus with a dilated portion

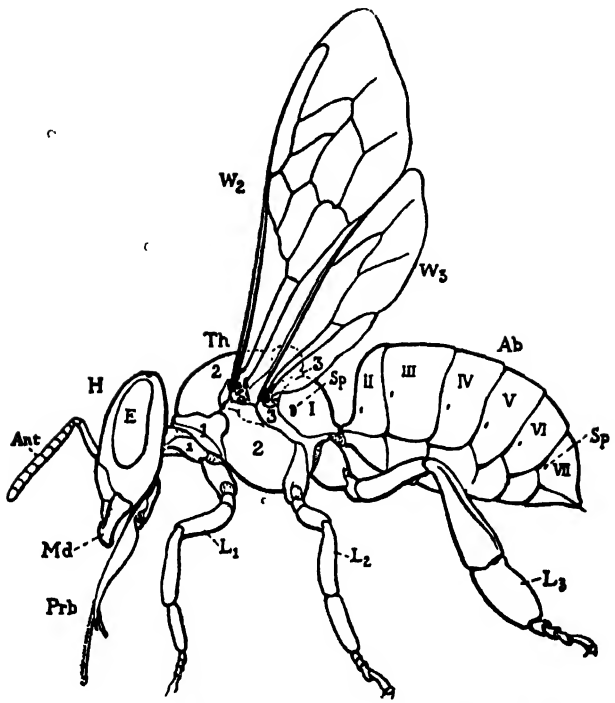


Fig. 1. External structure of the honeybee (Snodgrass)

Ab-abdomen; Ant-antenna; E-compound eye; H-head; L1, L2, L3-legs; Md-mandible; Prb-proboscis; Sp-spiracle; Th-thorax; W2, W3-wings; I-propodeum; II-VII-abdominal segments

called the honey-stomach, associated salivary glands, the stomach (ventriculus) in which digestion and absorption of food takes place and the intestine consisting of an anterior portion and a rectum which opens to the exterior through the anus. The excretory organs (malpighian tubules) remove the waste products of metabolism from the blood and pour the same into the digestive tract at the junction of the ventriculus and the hind intestine (Fig. 2).

The circulatory system is an open one and the blood bathes the internal organs. The blood, which carries the digested food materials to the tissues and removes waste products of metabolism from them, is circulated by a tubular heart. An elaborate respiratory system consisting of a network of air tubes connected to the exterior through

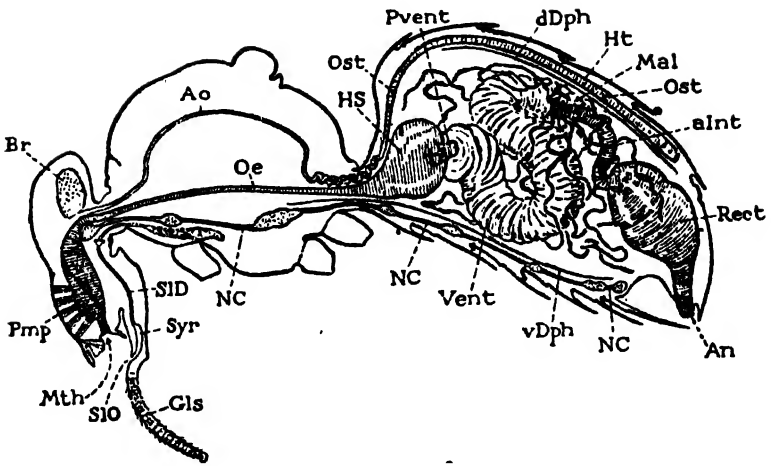


Fig. 2. Alimentary canal and internal organs of the worker honeybee (Snodgrass)

An-anus; aInt-anterior intestine;
Ao-aorta; Br-brain;
dDph-dorsal diaphragm;
Gls-tongue; HS-honey-stomach; Ht-heart;
Mal-malpighian tubule; Mth-mouth; NC-nerve cord;
Pmp-sucking pump; Pvent-proventriculus; Oe-oesophagus;
Ost-ostium; Rect-rectum; SlD-salivary duct;
SlO-salivary orifice; Syr-salivary syringe; vDph-ventral diaphragm;
Vent-ventriculus.

breathing pores (spiracles) is there to carry oxygen to the organs needing it and to remove the waste carbon dioxide from them.

The nervous system consists of a well-defined brain in the head and a ventral nerve cord with its seven pairs of ganglia extending to the posterior part of the abdomen. It sends out nerve cords which ramify the surrounding area and supervise and coordinate its activities. The muscular system is rather complicated. The wing muscles are most powerful and enable the bee to carry a load almost equal to her own weight. The wax glands are located on the lower side of the abdominal segments of worker bees only and secrete a liquid which on contact with air solidifies into flakes. It is used in building the waxen combs of a honeybee nest.

The reproductive organs are well developed in the drone (male) and queen (female) bees. The worker bees are female individuals but their reproductive organs are neither fully developed nor func-

tional. The sting apparatus in the queen and worker bees is a modified ovipositor and is used by the latter as weapon of defence unlike wasps and other stinging insects which use it for killing other creatures as prey.

Sense Organs. The honeybee is one of the insects which are most highly endowed with powers of sensory perception. Hair sensitive to touch are located on various parts of the body. On the antennae are located several thousand organs of smell. The taste organs on the mouth help the bee know if a fluid is sweet, acidic, alkaline or saltish. The ocelli help in differentiating between light and darkness and with the help of the compound eyes, the bee is able to perceive differences of colour, shape and form. It is able to distinguish between green, blue, yellow and ultra-violet but is more or less insensitive to red rays. As the compound eyes give a mosaic picture of the object, the bee is able to see moving objects more readily. The bee also has a time sense and a memory sense as it returns to the same patch in a field visit after visit and day after day at the suitable time.

A BEE COLONY

Honeybees are social insects and live in colonies with a highly organised system of division of labour. There are three castes: queen, workers and drones. In a normal colony there are one queen, 20,000-30,000 workers and a few hundred drones.

The Queen. The queen is the only perfectly developed female and is the mother of the colony. In the height of the season, she may lay 1,500 or so eggs in a day, which is almost twice the weight of her body.

She mates with the drone, the male bee, in the air only once in her life. The stock of male sperms, estimated at more than 2 crores, is preserved in a pouch-like structure in her body and she draws upon it for a life-time (which may be two or three years) to regulate the sex of her offspring. She can lay fertilized or unfertilized eggs 'at will'. From the former, workers and 'sexual' females or potential queens and from the latter drones are produced. The differentiation in the workers and queens is not due to the quality, as previously believed, but to the quantity of food fed to the larvae. The partial starvation, from about the third day, of the female

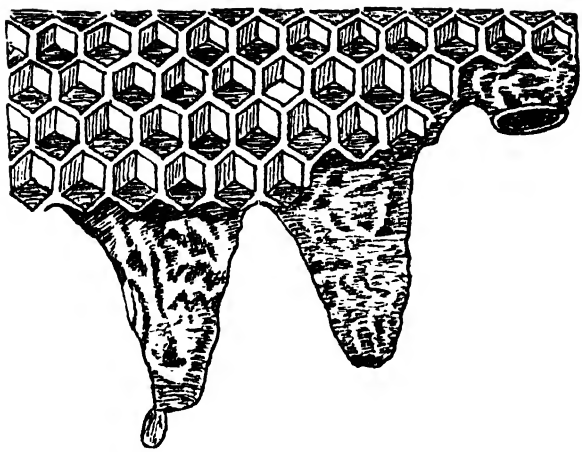


Fig. 3. Queen cells—freshly built, capped and empty with a cap, from which the queen has emerged

larvae that are reared in worker cells results in their differential growth and they become workers instead of queens, which they would have become if they had been lodged in the larger queen cells (Fig. 3) and had constant access to more food. The queen in her rounds over the combs lays eggs in the worker, queen or drone cells. The eggs are generally laid in concentric circles. As the old queen shows signs of decline in laying fertilized eggs, new queens are reared in specially prepared queen cells. On emergence a new queen roams about on the combs protected from her rivals by a *posse* of workers, feeds herself on honey and five to ten days after emergence she takes one or more flights out of the hive. On her flights she is followed by drones, with one of whom she mates in the air. Her mate dies during the act of copulation. After freeing herself from the dead body of her mate, the new queen returns home with the reproductive organs of male sticking out of her posterior. After a few days' rest she starts regular egg-laying*, first slowly and then vigorously, the number of eggs depending upon the amount and kind of food she receives from the workers and availability of a favourable temperature in the hive.

* Virgin and old queens (in whom the stock of sperms is exhausted) lay unfertilized eggs from which only drones are reared. This phenomenon is termed parthenogenesis—production of offspring without cohabiting with the male.

The queen is a heavily worked individual and does not in any way hold sway over the colony. She quickly transforms the food given to her by the workers into living eggs but lacks the motherly instinct of nursing her offsprings which function is solely delegated to the worker bees. It may be pointed out that without a queen mother in their midst, the days of the other colony members would be numbered.

The Worker. The worker bees are imperfectly developed females unable to reproduce, but possess all the maternal instincts. They are responsible for all the work necessary for the maintenance and welfare of the colony. Division of labour among the workers is on a physiological basis. Each worker bee performs different types of work in her lifetime and becomes fitted for various duties in succession as her age advances. During the first half of her life, she attends to such indoor duties as secretion of royal jelly, feeding of the brood, feeding the queen and attending on her, secreting bees-wax, building combs, cleaning, ventilating, cooling and guarding the hive, evaporating nectar and storing honey. During the second half of her life lasting three weeks she attends to outdoor duties and collects and brings into the hive nectar, pollen, propolis (bee glue) and water.

The field force of a colony divides itself into searchers and gatherers. The former fly around the surrounding area and bring back news of available food and communicate it to the latter by performing a round or tailwagging dance (according to the distance of the source). The direction of the locality is indicated by finishing each dance at a suitable angle from the direction of the sun. Information on the type of food is transmitted by a sample of the food as well as the scent adhering to the body. The gatherers go to the spot indicated by the searchers and get busy in small areas. They work diligently day after day until it is exhausted.

The worker bee has no individual existence and throughout her life she labours for the common good. In fact, she dies in harness. Her end comes during the flight to the flower. The proverbial busy-bee, it is estimated, gathers a dessert spoonful of honey in her life time. It has further been estimated that to collect a pound of honey, a bee has to make 40,000 trips of three miles each or has

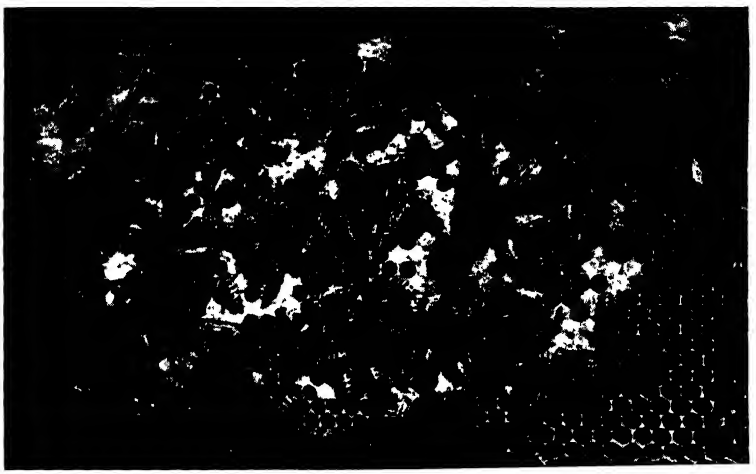


Fig 4. Part of a worker brood comb built on comb foundation by Indian honeybees

Fig A freshly built comb of Indian honeybees—*Apis indica* F.

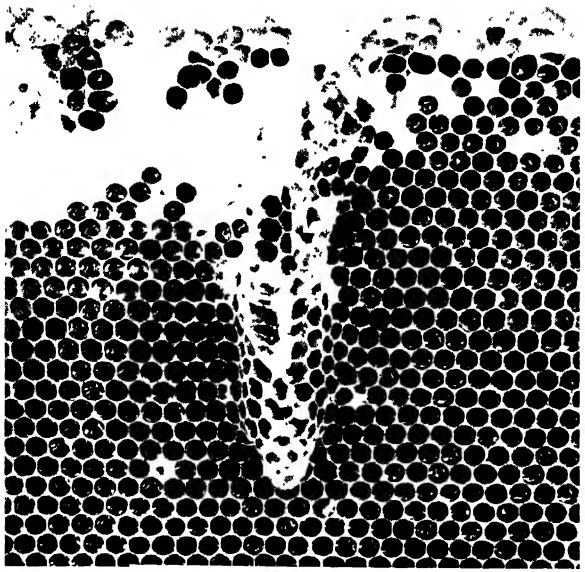


Fig. 6. A queen cell built in an Indian honeybee colony under the supersedure impulse

Fig. 7. A swarm of honeybees settled on a tree trunk

to fly a distance almost five times the circumference of the earth at the Equator.

The worker bee has been compared to a storage battery which cannot be recharged. She is capable of performing a definite amount of work and when that is accomplished she dies. Consequently, during the honeyflow season when she has to work at a tremendous pace she lives only for six weeks but during the off season, as in winter, her life extends up to six months. At Coimbatore in Madras State, which has a mild climate, plains variety of *Apis indica* worker bee on average lives for 50 days, the extremes being 44 and 54 days.

The Drone. The drone is the male bee. Its sole function is to mate with a queen. Since the latter mates only once in her lifetime, only one drone in thousands has the chance to perform this duty which costs him his life.

The drones are unable to gather food, but they eat a lot. Generally it takes three to six worker bees to feed a drone. They spend their time in enjoying the sun and fresh air. The drones are reared and tolerated during the breeding season in spring and autumn when new queens are to be mated. They are driven out of the hive to die of starvation before the monsoon and winter. The normal life span of an *Apis indica* (plains variety) drone has been worked out at 57 days in Madras State where climate does not move to the extremes of heat and cold.

The three castes of bees depend on each other for their existence. A lonely worker bee may not live for more than two or three days under the best of artificial environmental conditions. The queen bee also cannot form or even start a colony because she is physically incapable of secreting wax, building a comb, collecting food from the fields or rearing brood. In fact, she requires the services of several workers to feed and groom her and to do other things for her. A drone would not last beyond four hours without food. A normal colony must have a fecundated queen capable of laying plenty of fertilized eggs and a large number of workers of varying ages as the latters' fitness to do different tasks depends on their ages. A colony is termed 'weak' or 'strong' according to the number of worker bees it possesses. A colony of *Apis indica* bees with 10,000 to 15,000 bees (two to three lb.) is considered an average one at higher alti-

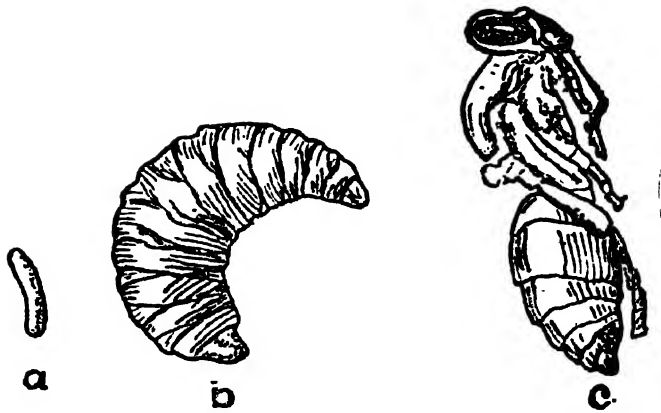


Fig. 8. Stages of bee development (highly magnified) a-egg; b-grub; c-pupa

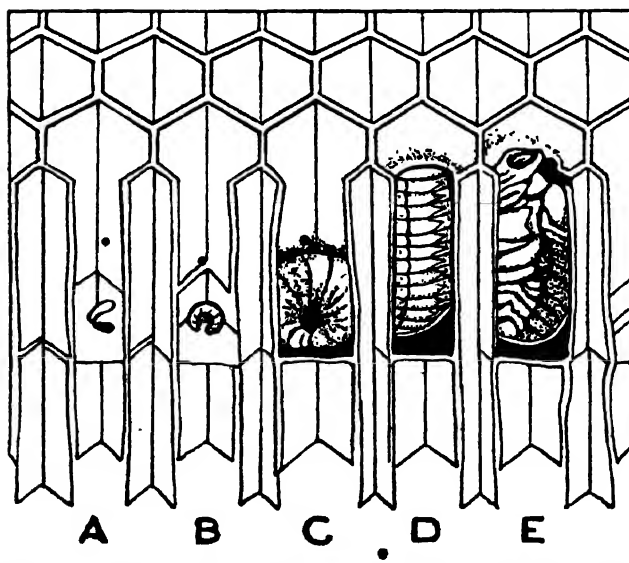


Fig. 9. Development of the bee in the comb (Diagrammatic) A-egg; B-freshly hatched larva; C-coiled larva; D-fully fed capped larva; E-pupa in a capped cell

tudes. Drones are not necessary to the normal welfare of a colony but they are needed only during the mating seasons to fecundate virgin queens.

Honeybee Development. The honeybee undergoes an indirect development (metamorphosis). The four stages of development are: the egg, the grub, the pupa (Figs. 8 & 9) and the adult. The mother bee glues or sticks a short delicate white tubular egg, slightly curved on one side, at the bottom of the cell of a comb. From this egg, a tiny, white worm-like grub hatches out and feeds voraciously on the food supplied by the nurse bees. When fully fed it weighs more than 1,500 times its original weight. The cell is capped over by the worker bees with a waxen cover and the fully fed grub spins a cocoon in the cell and enters a period of rest during which it transforms itself into a pupa. The major changes of structure both in the inside and outside of the body occur at the cost of the fat stored in the body by the grub. The pupa becomes similar in appearance to the adult bee, having developed mouth parts, legs, wings and other appendages of the body. The adult bee emerges after cutting the cocoon and the waxen capping of the cell. Table 1 shows the time taken by the three castes of the Indian honeybee in the three stages of development.

TABLE 1. DURATION (IN DAYS) OF THE LIFE CYCLES OF DIFFERENT CASTES OF INDIAN HONEYBEE—*Apis indica* F.

Caste	Duration			
	Egg stage	Larval stage	Pupal stage	Total
Queen ..	3	5	7-8	15-16
Worker ..	3	4-5	11-12	18-20
Drone ..	3	7	14	24

The eggs do not require any attention from the nurse bees except that they must be moistened a little, just before the tiny grubs hatch out of them. The young grub is literally flooded with food called royal jelly by the nurse bees by visiting it more than 1,300 times a day. The royal jelly is a secretion of special glands located in the head region of the nurse bee and is supplied to young

grubs of the three castes up to the third day of their development. Then the composition of the food given to the grubs destined to become queens, workers, and drones is somewhat varied. As stated above, the sex of potential queens and workers is considered to be determined by nourishment conditions under which the grubs develop. The hive bees do not bestow any further attention on the young ones once the brood cells have been capped over except that they regulate the hive temperature to about 90°F at which development of the brood progresses normally. In emerging from the cells as adults the young bees are not helped by others and once they are out they are capable of taking care of themselves.

POINTS OF CASTE DISTINCTION

The points of distinction among the different castes of bees in a colony are outlined below:

Egg. In appearance and size the eggs of different castes are alike. They are, however, usually laid in the cells provided for rearing the different castes.

Grub. The grubs of all castes also look similar but the queen and drone grubs are larger than the worker grubs during the later half of their development.

Pupa. The drone and worker (or queen) pupae can be distinguished by examining the eyes. In the case of the former the eyes meet over the head, and in the latter they are far apart (Fig. 10).

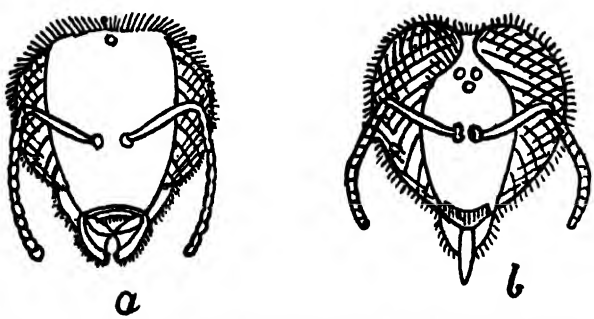


Fig. 10. Front view of the head of (*a*) worker, and (*b*) drone

Further in the brood comb the worker pupa has a flat capping with a dull and dry appearance and drone pupa has a convex capping,

with a hole in the centre in the case of *Apis indica* bees (Fig. 11). During the honeyflow season the cap may be covered by a further layer of wax. The flat capping of honey cells has a shiny appearance.

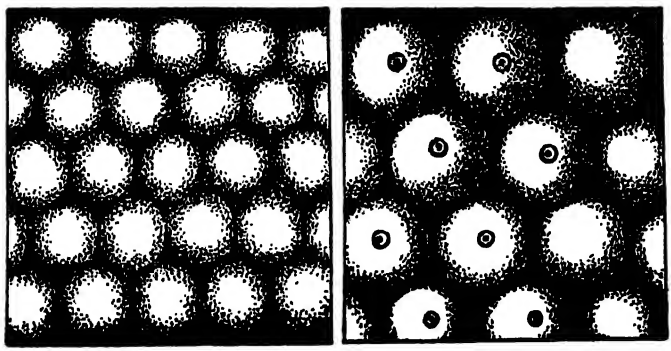


Fig. 11. Cappings of brood cells—*left:* worker (flat) and *right:* drone (bulged with a hole in the centre)

Adult

1. The eyes of a drone meet over the head and are far apart in the case of a worker and a queen.

2. The abdomen of a drone is black and has a rectangular shape with a blunt free end without a sting. In the case of a worker, the abdomen is striped, triangular in shape and has a barbed sting. In the case of a queen the abdomen may be golden brown (*Apis florea*), shining black (*Apis indica*) or dark (*Apis dorsata*) in colour and triangular in shape (more elongated than the worker's) and provided with a sword-shaped sting.

3. A queen's wings appear shorter than a worker's because of her proportionately longer abdomen.

4. The thickness of thorax of a worker is smaller than that of either a queen or a drone. In the case of *Apis indica* (hill variety—Nagrota—3,000 feet) the thickness of the thorax of a worker varies from 0.133″ to 0.141″ and that of a queen from 0.172″ to 0.180″. This fact is utilised in devising a useful appliance called the queen excluder described on another page.

5. A worker has a well-developed tongue for sucking nectar, highly modified legs provided with pollen brushes, a pair of pollen

TABLE 2. SIZE OF THE CELL OF

Bee	Locality	Type of comb
1. *Apis dorsata*	Nagrota (Pb.)	brood comb
2. *Apis florea*	Lyallpur (Pb.)	worker ,,
	Pusa (Bihar)	,, ,,
	Allahabad (U.P.)	,, ,,
	Lyallpur (Pb.)	drone ,,
3. *Apis indica*	Raison (Pb.)	worker brood
	Nagrota (Pb.)	,, ,,
	Madras	,, ,,
	Nagpur	,, ,,
	U.P.	,, ,,
	Travancore	,, ,,
	Raison (Pb.)	drone ,,
	Madras	,, ,,
4. *Apis mellifera*	U.S.A.	Worker ,,
	Europe & U.S.A.	,, ,,
	U.S.A	drone ,,

THE BROOD COMB OF HONEYBEES

No. of cells in four linear inches	No. of cells in a sq. inch	No. of cells in a sq. decimeter	Depth of cells in mm.	Thickness of comb in mm.
18·76	25·66	796·10	16·87	33·35
32·89	76·88	2380·61	..	..
36·00	..	..	..	..
36·00	..	..	..	..
21·14	32·38	1003·94	..	..
21·25	32·68	1013·17	11·49	22·45
22·01	..	..	..	..
24·76	43·64	1352·91	10·12	19·52
25·13	45·53	1411·37	9·92	18·52
21·89	34·13	1057·91	11·36	21·90
23·85	39·95	1238·42	..	..
17·65	22·56	699·42	13·41	24·98
22·05	34·88	1081·17	11· 7	22·00
..	27·00	838·00	..	..
19·30	..	763·00 to 954·00	..	..
..	18·00	..	..	..

baskets (on the hind pair of legs) and wax glands. In queens and drones neither the tongue nor the legs are so modified ; nor the wax glands are present.

COLONY NEST

The nest of a honeybee colony comprises of a single waxen comb made of hexagonal cells on both sides of a midrib in the case of *Apis dorsata* and *Apis florea* bees or a series of parallel combs in the case of *Apis indica* and *Apis mellifera* bees. The combs are attached to the lower side of a tree branch or to the ceiling of a cavity. They are built downwards. Freshly built combs are generally white (Fig. 5) but become dark with age. In the cells of a comb, the bees store honey and pollen and raise brood. Usually honey is stored near the point of attachment of the comb, then pollen and further down are worker brood cells (Fig. 4) followed by drone brood and queen cells, the last built along the outer boundaries of the comb. During the honeyflow season honey may be stored in the various types of cells mentioned above. Some of the combs may be full of honey alone. The size of cells varies for worker and drone brood and again for various species of bees. A consolidated statement on the size of various types of cells is given in Table 2.

Partially filled or inhabited cells have no caps and are termed 'unsealed' or 'uncapped.' They may contain 'unripe' honey or developing brood. If the honey is ripe or the grubs are fully fed the cells are capped, the nature of capping depending upon the contents. The cells containing ripe honey have flat airtight cappings. Pollen cells are generally not capped. It is, however, preserved for future requirements by partially filling the cells with honey and capping them as honey cells.

The brood is generally compact and is broadly spherical in outline, the size of the sphere being maximum during the breeding season, and shrinking during the 'dearth period' when there is lack of food in the fields. More than 1000 sq. inches of sealed and unsealed worker brood (about 30,000 young ones) have been recorded in strong colonies of *Apis indica* bees during the month of April at Nagrota (Punjab). The months of June and September in the plains and lower hills and June and November in the higher hills have been noticed to be broodless periods.

Fig. 12. A colony of rock bees—*Apis dorsata* F. (Dammerman)
(*a*) comb without bees, (*b*) comb with bees in position

Fig. 13. An *Apis florea* F. comb showing worker, drone and queen cells

Yearly Routine. Honeybees remain active practically throughout the year. In a severe winter, however, they neither do much work nor rear any brood. They sit clustered in the hive with the surface bees forming an insulating layer. When necessary they raise the temperature of the cluster by eating honey and thus generating heat.

With the advent of spring, brood rearing begins in earnest and the colony becomes strong from mid-March to mid-April. The nest becomes crowded and the bees begin to make preparations for swarming. At this time the queen cells are built along the bottom and sides of the comb. When a new queen is ready to emerge out of its cell, the old queen and a large majority of workers representing all age-groups but mostly two to three weeks old (who have previously filled themselves with honey), leave the nest on a warm day to start a new colony. After flying for some time, the swarm (Fig. 7) settles on a nearby tree, bush or some other suitable object in the form of a cluster. 'Scouts' are sent out from this place to locate a desirable site for a nest. The whole swarm moves to the new site within 2 to 48 hours of its departure from the parent colony.

In the parent colony either of the two things may happen. The first queen which emerges after the primary swarm is gone, may kill the baby queens in other cells and establish herself as the queen mother. Or another swarm may issue from the colony and it may be followed by three or four swarms until the strength of the parent colony is completely depleted. The queen that emerges last 'holds sway' over the colony.

After the swarming fever is over the bees in the parent colony settle down to the routine work of gathering nectar and pollen. The colony gains strength and surplus honey is accumulated in the hive. There is a varying period of broodlessness during May and June. Later, brood rearing proceeds at an indifferent rate through the monsoon and autumn. However, in the higher hills where there is a honeyflow in autumn the colonies increase in strength and store surplus honey for winter. There is a short period of broodlessness again in November after the honey harvest. When the queen cannot produce enough fertilized eggs to replace the workers which die off, the colony loses in strength. But before this happens drones are raised and a few queen cells (1, 2 or 3 compared with 6 to 30

queen cells raised during the swarming period) are built (Fig. 6) and queens raised in them. The first virgin that emerges goes out for mating and on return supersedes her mother after killing her and other potential rivals. Sometimes, however, both mother and daughter work together for sometime before the old queen disappears. If this supersedure coincides with a honeyflow period a swarm or two may issue from the parent colony before it settles down to work. If, as a result of accident, the supersedure attempt is not successful and the old queen is lost, some of the younger worker bees are fed on nutritious diet to develop their reproductive organs. 'Laying or fertile workers' lay unfertilized eggs in worker brood cells (since they do not mate with a drone). From such eggs comparatively small drones are reared. They are capable of producing viable sperms, but this expedient does not help the colony because queens cannot be produced in this way. Consequently, the colony peters out in two or three months.

CHAPTER 3

SPECIES OF HONEYBEES

THREE species of honeybees namely *Apis dorsata*, *Apis florea* and *Apis indica* are met with in India. Their characteristics as well as those of the European bee, *Apis mellifera*, which has been introduced in many parts of the world are described below. The stingless bee which yields some honey has not been ignored. Let us first take up the species which has been variously called giant bee, rock bee, *Apis dorsata F.*, *dumna*, *bhandaur* or *bhanwar*.

Rock Bee. It is met with all over India in the plains and in the hilly tracts up to a height of 3,500 feet above sea level*. The colonies shift from place to place to avoid extreme cold or in search of honey flora. For example, in the Punjab its colonies arrive in Nagrota (Kangra) in March and April and descend to the plains in June before the monsoon. During migration the swarms are known to make short halts *en route*. They fly fairly high and fast and a sound akin to, but fainter than that of a passing aeroplane, is heard by farmers working in the fields. Swarms of this bee are known to have crossed mountain barriers also. During winter they are abundantly met with in the plains.

A rock bee colony builds a single comb measuring about five to seven feet from side to side and two to four feet from top to bottom (Fig. 12). The comb may be suspended from rocks, ceilings of neglected and uninhabited houses, high hedges (*bannah—Vitex negundo*) or branches of such tall trees as *banyan* (*Ficus bengalensis*), *pipal* (*Ficus religiosa*), silk cotton (*Salmalia malabarica*), mango (*Mangifera indica*), *jaman* (*Syzygium cumini*), etc. Dozens of colonies may be found on one tree. The author counted six dozen colonies on a silk coton tree in New Delhi in May, 1949. Fletcher reports that in 1915 he saw 156 colonies in a 'bee tree' in South India. Such a concentration of colonies may well be termed 'Nature's apiary in the air'. The same trees, ledges of rocks, eaves of houses, etc. are known to be used for nesting purposes by bee colonies year after year. The belief

* Occasional reports of nests of these bees from higher altitudes (Simla-7000 feet) have been received.

among the villagers that the colonies remember their old sites has no scientific basis as the worker bees are short-lived creatures. There may, however, be some similarity between this occurrence and settling of swarms on a favoured limb of a particular tree in an apiary. In the latter case, "the scent" left on the limb by the previous swarm may attract the new swarm.

The comb has hexagonal cells and measures about 18.75 cells to four linear inches. The worker and drone brood cells are equal in size. The average thickness of the brood comb is 1.3 inches and the thickness of the top portion of the comb, where honey is stored, may be as much as nine inches (see also Table 2).

The light brown worker bee measures 16-18 mm. in length. About 3,000 such bees would weigh one lb. Their average tongue length is 6.683 mm. as compared to 6.438 mm. of *Apis mellifera* and 5.525 mm. in the case of *Apis indica* bees. The queen is darker in colour than the workers and about 1/5 as long again as the workers and about 2 mm. broader in the thorax so that 7 mm. wide slots of the queen excluder are required for her easy passage as against 5 mm. wide slots required by the workers. The drone has a black colour and is as big as a worker. Drones are described by some as very beautiful and elegant creatures as compared with the workers and queens.

The rock bees are good honey gatherers and have been observed to begin the day's work earlier and stop it later than *Apis indica* bees do. They store surplus honey generally in the front portion of the comb which is harvested twice or thrice during the season by professional honey-gatherers. A single colony may yield up to 80 lb. of honey during a year. This bee has a ferocious temperament, is easily provoked and attacks *en masse* man or beast often with fatal results. When enraged, the bees pursue their victim over long distances. The latter cannot escape even if he may dive in water as the bees hover over the surface and attack as soon as he raises his head for breath. They are, however, sensitive to smoke and are successfully managed in this way as any other species of honeybees. Professional honey-gatherers and modern beekeepers are able to handle them with impunity.

The high honey-yielding qualities and industriousness of these bees have lured many a beekeeper to keep them in movable frame

hives or in any other way under his management. Success has so far eluded them, but their efforts have helped them know the bees' habits better. From the long list of workers who have tackled this problem, a few are mentioned here. Dathe of Germany and Benton of the U.S.A. made special trips to India in the last century to take these bees to their respective countries, but the colonies did not reach beyond Palestine. Roepke experimented for several years in the Dutch East Indies (Indonesia) with these bees and was successful in keeping several colonies imprisoned in specially designed cages for several weeks at a stretch but some time after the "screens" had been removed the colonies would abscond suddenly without any apparent cause. In India, Thompson in Travancore and Millen at the Allahabad Agricultural Institute have had a similar experience during the 1940's.

Observations on the biology of these bees show that, in general, their behaviour is similar to the better known species of honeybees. The egg placement in the cells, the concentric arrangement of brood in respect of age, the raising of queen cells, issue of swarms, round and tail-wagging dances by the searcher bees on the comb, etc. have been noticed to be broadly in line with other species. Preliminary attempts by the I.C.A.R. Beekeeping Research Station in crossing *Apis dorsata* (drones) with *Apis indica* (virgin queen) with the aid of an artificial insemination syringe have not met with success. In another experiment a few of the *Apis dorsata* larvae placed in artificial queen cell cups were reared by *Apis indica* workers in their colonies and queen cells capped, but no adult queens, however, emerged. The pupae from capped worker brood combs of *Apis dorsata* are thrown out by *Apis indica* bees if such combs are introduced into their colonies and the empty combs often used to store honey. It must be emphasized that a great deal of more systematic work is needed to explore fully the possibilities of incorporating the traits of *Apis dorsata* in *Apis indica* or for keeping *Apis dorsata* colonies under beekeepers' management for bigger profits.

Little Bee. The next to be described is the little bee (*Apis florea* F.) or *chhoti makhi*. This is a plains species met with all over India but rarely lives in places higher than 1,000 feet above sea level. These bees migrate frequently. A colony seldom remains at one place for more than five months at a stretch.

It makes a single small comb usually about the size of the palm of the hand (Fig. 14). Larger combs measuring one and a half feet long and one foot deep are also known. The comb is suspended from branches of bushes, hedges, trees, eaves of buildings, house chimneys, empty cases, piles of dried sticks, etc. It is known to make 32.8 to 36 worker brood cells to four linear inches. There are 21.1 drone cells to four linear inches (Table 2). Honey is stored in the top portion of the comb which may become 2" to 2½" thick at the end of a honeyflow season.

The worker bees with deep black and white stripes on the posterior half of their bright orange abdomen are comparatively much smaller than the golden brown queen and black drones with smoky grey hair. These bees are poor yielders of honey, a comb yielding about a pound or two of honey which is rather thin in consistency. These bees are not so prone to stinging and are sometimes termed 'stingless'. However, they do have a sting which causes a swelling. They are very prone to swarming and five or more swarms may be sent out by the parent colony. They are creatures of the open and do not stand captivity well.

Attempts at gently shifting the colonies (along with the branches to which combs are attached) to an orchard at blossoming time for pollination or to a more suitable place for purposes of easier observation of their activities have been made by various workers in different parts of the country with uneven results. Some colonies adapt themselves to the new home while others abscond right away leaving honey, capped and uncapped brood and still others decamp in about three weeks—the period taken to hatch all brood.

There are two popular beliefs associated with these bees. First, that the honey produced by them has special medicinal qualities, and secondly, that the bees make honey during dark nights and spend moonlight nights in drinking it up. It is very difficult to substantiate or check up the first notion experimentally, but there is no reason to believe that the additional medicinal qualities, if any, are due to any special secretions added by these bees to the nectar collected by them. The medicinal qualities, if any, must be attributed to the nectar of the plants found in the locality. They are available equally to these and other species of bees in that locality. To test the veracity of the second belief, weight records (for nine years,

1936-1944) during the honeyflow of an *Apis indica* bee colony at Nagrota (Kangra)* were critically examined by Rahman and Singh and honey-gain days were found to fall almost equally in the bright and dark halves of the lunar month. It became clear that there was no scientific basis for this belief. Other workers also have come to the same conclusion.

Indian Honeybee. The third species, the Indian honeybee, (*Apis indica* F.), is also called *darohla, mahun, mauna.* This bee is found practically throughout India. There are several regional varieties or strains of it. The hill and plain varieties are two recognised strains. The worker bees of the plains variety are comparatively smaller and look yellower. At higher altitudes larger and darker bees are found. Whereas the plains variety makes 24 to 25 worker brood cells to four linear inches, bees at Nagrota (3,000 feet above sea level) make 22 and those at Raison (4,500 feet above sea level) make 21.25 (Table 2). The average tongue length of the worker bees at Madras has been found to be 4.39 mm., at Nagrota, 5.525 mm. and at Katrain (5,000 feet above sea level) 5.218 mm. The average number of hooks on the right hind wing of Nagrota bee are 17.93 and of a Katrain bee 18.4.

This bee lives in the cavities of tree trunks (Fig. 15), mounds of white ant colonies, hollows of rocks and other common closed and covered places. Under domestication it makes its home in all kinds of cavities or recesses. Hollowed-out logs, wooden boxes, packing cases, kerosene empties, mud receptacles (Fig. 17), earthen pitchers, wall recesses made from any of the above materials and unused almirahs are the common types of abodes used by the bee. Unlike its *Apis dorsata* and *Apis florea* sisters it makes a series of parallel combs like its European relation *Apis mellifera.* The habits of this bee vary from strain to strain. Generally speaking, it is a bee with a gentle temperament and is easy to handle It responds to smoking though in certain cases bees show a little uneasiness. It is industrious and a good gatherer of honey. Due to incessant swarming, ravages of bee enemies, lack of honey flora and the resultant absconding, one comes across a large number of weak colonies. On the average, colonies yield 8 to 10 lb. of honey each

* Records for *Apis florea* F. or *Apis dorsata* F. cannot be easily accumulated.

at higher altitudes and 3 to 5 lb. each in the plains per annum. Selection work conducted among the local strains at the Government and private apiaries in different States, coupled with better management practices in movable frame hives shows that there is a great scope for improvement. Several instances of maximum yields of over 40 lb. of honey per annum from a colony of bees have been reported from different parts of the country. The outstanding performances are an average of 28½ lb. of honey per colony from 40 colonies, the best colony yielding 97 lb. at the Government Bee Farm, Katrain (Punjab) in 1942 and an average of 33.5 lb. of honey from 15 colonies, the best yielding 67 lb. at the Talwar Apiary in the N.W.F.P. (Western Pakistan) in 1942.

These bees are prone to heavy swarming, absconding, robbing and developing a large number of laying workers. Such defects, however, can be remedied with suitable manipulatory practices. In addition, these bees are poor propolizers and are helpless against the wax-moth which does considerable damage particularly during the rainy season. The latter type of defects may perhaps yield to cross-breeding with *Apis mellifera* bees by artificial insemination.

European Bee. This bee is found all over Europe and has a large number of well-recognised varieties and strains. The Italian variety is considered to be the best and has been introduced in almost all countries of the world. It has achieved phenomenal success in the U.S.A. and Canada. This bee is similar in habits to the *Apis indica* bee in that it makes its nest in enclosed spaces and builds parallel combs. It has many desirable traits. It maintains a prolific queen, swarms less, has gentle temperament, good honey-gathering qualities and guards the hive against bee enemies except wasps. Though still met with in straw skeps and box and log hives in backward areas, it has adapted itself well to the movable-frame hives and modern methods of management. Average yields of 100 to 400 lb. per colony in apiaries of 500 or more colonies are common in the U.S.A. and the best yield so far recorded is that of 1000 lb. from a colony in the same country. A bee-keeper of South Africa in 1949 reported a yield of 2,112 lb. 12 ozs. from a multi-queen colony.

Special strains have been developed for gentle temperament, honey-gathering, pollination and other qualities. With the develop-

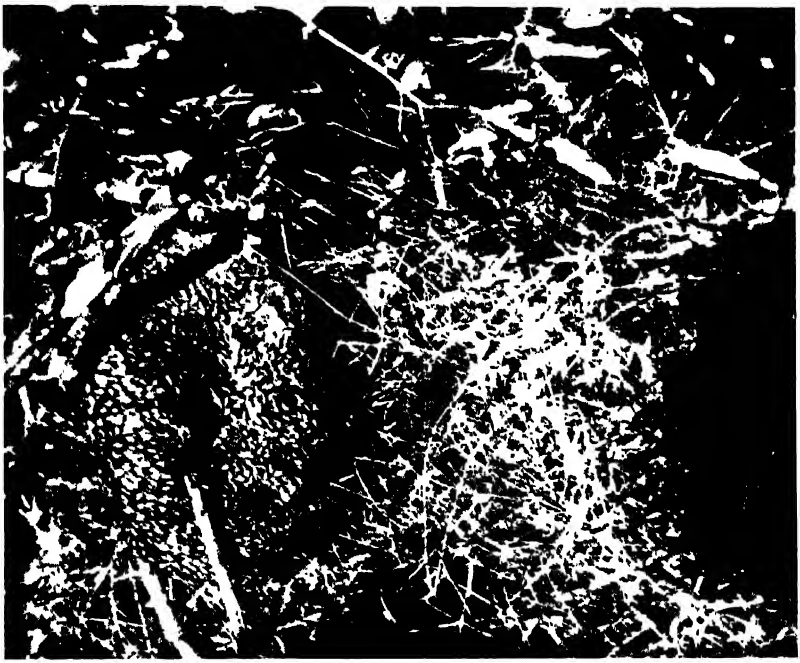


Fig. 14. A colony of little bees (*Apis florea*) on a citrus plant

Fig. 15. Entrance of a bee colony established in the hollow of a *banyan* tree

ment of cross-breeding through artificial insemination almost tailor-made strains of bees are in the course of production at the field stations of the Federal Bee-culture Laboratory of the U.S. Department of Agriculture.

Since 1880 considerable interest has been taken in the importation of Italian bees into India. About two dozen separate consignments of Italian queen bees, nuclei and colonies from England, Italy, the U.S.A. and Australia are on record. Generally, the bees arrived in this country depleted in strength and fell a prey to the robbing of *Apis indica* bees, the ravages of wasps, monsoon weather, etc. Two consignments of considerable size were those by Baldry in Poona in the twenties (two dozen colonies) and Thompson in Travancore in the thirties (one dozen colonies). Both were able to rear queens locally and increase the number of colonies and obtain some honey. In 1954 some colonies of the Italian bees were known to be available in Kashmir State.

The first consignment of Italian bees by air from the U.S.A. was received in April, 1945. A dozen queen bees were received in Kashmir State from Italy in 1952. It is hoped that the speedier method of transport may help in further experiments which may be undertaken to settle the Italian bee in India and to cross-breed it with the Indian bee. Such importations should, however, be limited to well-equipped Government sponsored establishments and private beekeepers are urged not to import foreign bees to avoid several adult and brood diseases which are common among bees available in Europe and America. These diseases once introduced into India may ruin the Indian beekeeping industry as they once did in Europe and America.

Dammar Bees. Several species of these bees which are called *Melipona* spp. and *Trigona* spp. are met with in different parts of India (Fig. 16). They are the smallest of the honey-yielding bees. They do not sting but bite. However, it is wrong to call them 'stingless' as they have a vestigial sting. They build their nests in the hollows of trees or rocks or in walls. The sac-like combs are usually built from a mixture of resins and wax held together by propolis. Honey and pollen are stored in these sacs. The honey yield is rather small and is difficult to extract. A substance known as 'Bees Dammar' or 'Pive-nyet' obtained from these colonies may

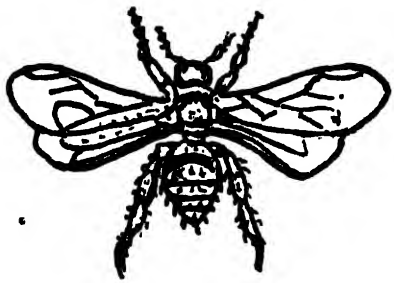


Fig. 16. A worker bee of *Melipona rufirentris* (Magnified)

be used in varnish and is employed in Burma for caulking boats to make them waterproof.

Which Bee to Keep. If beekeeping is to be remunerative the bees must be amenable to being kept under the care and management of the beekeeper so that he may come to their help in time of difficulties, i.e., starvation, robbing, cold, attacks by enemies etc. Moreover, he should be able to check their preparations for swarming or absconding. For this purpose the movable frame hive (described in Chapter 5) is a handy tool in the hands of a beekeeper and a good abode for the bees as it gives them protection against sun, rain, cold and the enemies, and affords them facilities to build combs inside it. Both *Apis dorsata* and *Apis florea* bees build single combs, and love open air life. Attempts at keeping them in the hives under the care of man have failed so far. The nests built by Dammar bees are not capable of being duplicated on a mass scale and the small quantity of honey yielded by them does not encourage one to try to keep them. Thus we are left to select from two species—*Apis indica* and *Apis mellifera*. The qualities that make hive bees desirable are: gentle temperament, prolific queen which keeps a colony strong, tendency to swarm less, absence of absconding, ability to guard against bee enemies particularly wax-moth, wasps and black ants, industriousness, good honey-gathering qualities, and adaptability for modern hives and methods of management.

Judged from these standards the Italian bee is the bee *par excellence* but as stated earlier, attempts at settling it in India have not so far been successful. The Indian bee (*Apis indica*) is our next choice and its hill variety has proved its worth under modern methods

of management. Intending beekeepers are advised to begin with the hive bees available in their locality and to select a suitable strain from amongst them, keeping in view the points outlined above. Queens of improved selected strains may then be obtained from reputed apiaries in the hills and introduced to these hives.

Selection among bees is a continuous process and any colony found to be deviating from the standard strain in any respect should be 'requeened' with the desired strain of bees.

Alongwith the improvement of *Apis indica* bees, every effort should be made to encourage *Apis dorsata*, *Apis florea* and Dammar bees as these bees play an important part in the economy of nature by pollinating most of our agricultural and horticultural crops. But for the services rendered by the bees their propagation will be adversely affected. It has been suggested that *Apis dorsata* should be exterminated in order to provide more forage for *Apis indica* bees. It is doubtful whether *Apis indica* bees will be able to catch up with the work of pollinating wild and cultivated crops at present being performed by *Apis dorsata* and other bees within any reasonable length of time in spite of all the help and facilities that modern bee-keeping may provide for them.

CHAPTER 4

INDIGENOUS METHODS

THERE is ample scope to improve the beekeeping industry in India. Scientific methods, modern equipment, thorough study of local conditions and better handling of honey and beeswax after gathering will make it a more paying occupation than it is today.

The present position of the beekeeping industry in India may be studied in two parts: Single-comb bees and hive bees.

Single-Comb Bees. These are *Apis dorsata* and *Apis florea*. These receive little attention from their owners and the colonies migrate according to the time of the year. Honey from both types of colonies is extracted by professionals at the end of the honeyflow season and the collections are shared equally between the owner and the professional. Plucky young men often raid easily approachable but unclaimed colonies in wastelands and in jungles several times during the honeyflow season and share the booty of unripe honey more for their own consumption than for sale. The Forest Departments of several States auction the rights of gathering honey and beeswax from *Apis dorsata* colonies and the State Exchequers collect lakhs of rupees every year.

Apis florea. Honey is gathered from these colonies usually early in the morning. A little cold water is sprinkled on the bees and the honey portion cleared from the bees. The brood comb is then cut off and placed in a nearby bush, etc. along with the clinging bees. The honey comb is then either scraped off its attachment or cut off whole along with the branch. When several such combs have been collected, any brood and pollen cells are separated from them and honey is squeezed out of the remaining mass by pressing it in a piece of cheese cloth.

Apis dorsata. Colonies of these are harvested at dusk or at night. Two or more professionals work at a time. Smouldering cowdung cakes or branches of trees are usually used to smoke away the bees. Sometimes a little sulphur powder is added to make the smoke more effective. After wrapping himself well in a sheet of cloth, the professional reaches the colony nests, smokes away the

bees and clears the front honey portion of adhering bees with a broom made of twigs. The portion is cut with, say, a sickle and collected in a wide utensil. Sometimes, the honey comb is collected on a sheet of cloth spread below. The comb's collection is then freed from adhering bees, pollen or brood combs, and the honey is squeezed out by pressing the mass through several thicknesses of cheese cloth (Fig. 18).

The gathering of honey from rock bee colonies built on difficult rocks is a more hazardous job. A very useful account of such operations in the Nilgiri Hills by Mr. A. Merreyn Smith was published in *The Statesman* in 1895. Reproduced by Watts (1908), it is as follows:

"A strong stake was driven into the ground 15 or 20 feet away from the edge of the precipice, as a purchase for the rope, as it was being lowered down the face of the precipice. One end of the cane-rope had a double loop, in which a koo-ramber seated himself, his feet being supported by a short stirrup of bark. A light, reed-like bamboo, 20 feet long, armed with a reaping hook at the end, served to cut the combs from the rocks. A small landing net below the sickle received the combs as cut. A light cord, running through a loop about 10 feet above the head of the gatherer, and fastened to the sickle end of the rod, enables the gatherer to use the rod as a derrick, which he can raise, lower and swing to any position, without being inconvenienced with the weight of the combs in the net. When the net is full, he empties the contents into a large close-framed basket lined with leaves, which is suspended from a separate cord, and this basket is drawn up when filled. The occupation of gatherer is extremely dangerous and requires steady nerves. In many cases, the men are suspended 400 feet from the top of the cliff with many hundreds of feet below them to the bottom of the precipice. These cane-ropes are immensely strong and stand more rough usage than one made of fibre, and they are also extremely light. The suspending rope is shifted about from place to place in answer to the signals with the hand from below. Immediately the bees are disturbed, they crowd round the gatherers in myriads. The men are literally covered with a coating of bees from head to foot and present a most curious appearance, just as if they were covered with rusty chain armour, each link of which is in motion.

The pungent smell of the wood-smoke from the bodies of gatherers has a kind of paralysing effect on bees and prevents them from stinging. The flight of bees thus disturbed could be distinctly seen from where we were half a mile off, and resembled a flight of locusts. We could even hear the humming noise made by the irritated insects. In about two hours all the combs within reach had been collected and the ropes were drawn up."

Apis indica. Many village folk take interest in keeping honeybees and provide various types of recesses or hives in their houses for their colonies. The places are not much different from the natural abodes bees select for their homes and may be divided into two groups.

1. **Wall or Fixed Type.** During the construction of their houses the village folk make rectangular recesses of varying dimensions. Sometimes mud receptacles are placed in the walls. In Nainital District of U.P., it has been found that most recesses can be easily modified to fit movable frames of 12″×7″ size. These have a small hole on the outside which the bees use as entrance. A large opening on the inside covered with a board or basket held in place with mud or cowdung paste is used to gather honey and to observe what is going on in the colony.

2. **Movable Type.** This type comprises of hollowed-out logs usually a yard long and one and a half feet in diameter (in Khasi Hills) (Fig. 25), empty wooden boxes, mud receptacles, earthen pitchers, and the like which are placed in *verandahs*. These also have an entrance hole and an opening at the back as in the first type.

Swarms of bees come to the recesses, usually, of their own accord. Some enthusiastic beekeepers catch clustered swarms from trees, etc. or place decoy hives in the jungle to lure stray swarms and transfer them to these recesses. The bees are generally left undisturbed until it is time to collect honey when after smoking the bees away and sprinkling some water over them, the honey combs are cut away. Honey is squeezed out of the combs by pressing it through a piece of cheese cloth (Fig. 18).

The honey collected from the three species of bees is taken to the market in earthen pitchers, household utensils, empty kerosene tins and other improvised containers. At city stores, some of the honey may be bottled after furthers training. In the main markets

like Calcutta, Amritsar and Hoshiarpur, the usual packing is four-gallon kerosene tins.

BETTER METHODS NEEDED

The methods of beekeeping in vogue in the Indian countryside suffer from the following defects:

1. It is left entirely to chance whether a recess gets inhabited or not. It is thus not possible to keep a definite number of colonies and depend upon them for a living.

2. It is not possible to control the activities of the bees. They cannot be helped if they are queenless or molested by wax-moth, nor can they be checked from swarming or absconding. In fact, one remains absolutely in the dark about their privations or "intentions".

3. Robbing cannot be prevented.

4. The honey obtained is not pure for it contains brood juices, parts of bees' bodies, cocoons, pollen, wax and dirt. Besides, as the containers used for storing honey are neither air-tight nor insect-proof and storage conditions are insanitary, honey when offered for sale is often in an advanced stage of fermentation with unwelcome additions of dead black ants, houseflies and other insects.

5. Every time a colony is settled in a new hive, the comb is to be made afresh. The making of a new comb is costly as it costs the bees 10-15 lb. of honey to produce a pound of beeswax.

6. When honey is extracted, a large number of bees get killed. Little honey is left for the survivors with the result that the weakened colony lives in semi-starvation. This ultimately lowers the yield of honey during the next year.

7. No programme of race-improvement through selection among the local strains or by 'requeening' by improved ones from other areas can be promulgated.

BETTER BEEKEEPING

To make beekeeping profitable, the following requirements must be satisfied:

Every beekeeper must (i) have a definite number of colonies; (ii) maintain strong colonies of desirable strains of bees; (iii) produce pure and increasingly more honey per colony per year and

the same be offered to the consumer in attractive and hygienic containers; (iv) be able to ascertain activities of bees inside the hive and help them in their difficulties like starvation, robbing, attacks of bee-enemies and make them desist from their preparations for swarming and absconding and (v) institute a programme of race-improvement of the bees.

To achieve these objectives a beekeeper must make a proper study of local conditions, use modern equipment and utilise fully the knowledge gained in the West in beekeeping during a century of experimentation under vastly varying conditions of climate and honey plants. The phenomenal success of the beekeeping industry in the West is largely due to the method of keeping honeybees in movable frame hives every part of which is accessible and which can be expanded and contracted according to seasonal requirements. They not only provide a suitable home for the bees, but allow the beekeeper to manage the bees with ease. They enable the beekeeper:

(*a*) To keep a watch on the activities of the colonies.

(*b*) To strengthen them by feeding them sugar, syrup and pollen substitutes and uniting weak stocks to them.

(*c*) To 'requeen' them by rearing young queens in them or by introducing those of better stock.

(*d*) To check them from swarming and absconding.

(*e*) To protect them from enemies and inclement weather.

(*f*) To use comb foundation sheets so that strong regular combs are obtained.

(*g*) To extract honey by a machine worked on the centrifugal principle, so as (i) to obtain pure honey free from extraneous matter and (ii) to save the combs which can be given to the bees.

(*h*) To move them from locality to locality in order to (i) take advantage of the honeyflows from different types of bee pastures; and (ii) pollinate commercial orchards, vegetable gardens, etc.

In the beginning the reception to the movable frame hive, the comb foundation and the honey extractor in India was rather cold but sustained efforts in this country during the last two decades have produced gratifying results.

Fig. 17. An oven-type mud receptacle in a wall in Kangra District (Punjab) front view showing entrance

Fig. 18 Indigenous method of squeezing out honey

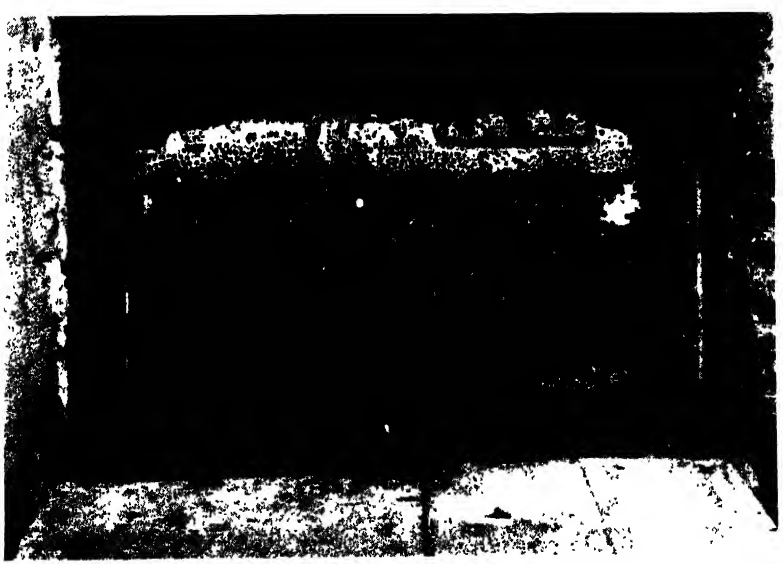


Fig. 19. A movable frame with honey comb and bees in a modified wall hive

Besides, intelligent use of the modern methods of bee management coupled with thorough knowledge of honey plants and honey-flow conditions of a locality are essential to establish the industry in that locality. Truly, no amount of equipment can make the bees produce surplus honey if the beekeeper's methods are unsuitable and he fails to forestall the requirements of his bees and to meet the same in time.

As far as single comb bees are concerned all efforts should be directed towards keeping the honey obtained from their nests pure and saving it from fermentation and keeping it free from all extraneous matter.

CHAPTER 5

EQUIPMENT

As mentioned earlier, the Revd, L. L. Langstroth discovered the principle of bee space in 1851 in the U.S.A. This is a space large enough to permit the free passage for a worker bee but too small to encourage bees building a comb and too large for bees depositing propolis (bee-glue) in it. It measures $\frac{1}{4}$" to $\frac{3}{8}$". Applying this principle, he devised a movable comb, top opening ten-frame hive. The frames hang free in the hive from the shoulders ensuring bee space on all the six sides. Frames of varying sizes were in vogue in different countries before World War I but the standard Langstroth dimensions (17-5/8" × 9-1/8") have been adopted in the U.S.A., Canada, Australia, New Zealand, South Africa and other major beekeeping countries.

In India various sizes of frames have been in use at various periods during the last 70 years. Their main features of construction have been the same as those of the Standard Langstroth hive. Table 3 gives the hive sizes used at different periods in various parts of the country.

Since size variations of bee colonies of *Apis indica* in the plains and hills are appreciable, it is likely that small colonies in large hives may get their brood chilled during a sudden cold spell and their surplus combs may get heavily attacked by wax-moth, etc. It is, therefore, advisable to adopt more than one standard dimensions of frames for India. However, any tendency to multiply the number of sizes of frames on such grounds as easy availability of kerosene tins, cavities in walls, etc. must be strongly deprecated as this may lead to the demand for 'custom built' hives to suit the requirements of individual colonies, not to say of particular localities. Standardisation of equipment has too many benefits to be lightly brushed aside. The author had the experience of handling bees in British Standard, Langstroth and Dadant frame hives at one time, and odd-sized frames nearing Newton frames at another in two apiaries and the resulting confusion can better be imagined than described.

TABLE 3. DIMENSIONS OF MOVABLE FRAMES USED IN INDIA

Name	Dimensions of brood frame	Super frame	Various names under which promulgated in India
British Standard	14″ × 8½″		Standard Hive (Ghosh 1915)
			Wall Hive of Ghosh (1915)
Kerosene Box	11½″ × 8½″		Introduced by Ghosh (1915)
Langstroth ..	17⅝″ × 9⅛″	17⅝″ × 9⅛″	American Hive
		17⅝″ × 5 11/16″	Jeolikote No. 1
			'Pant', Kathjoo, 'Kidwai' etc. Hives.
			Two-storey Langstroth Hive
Dadant	18½″ × 11½″	18½″ × 6½″	Kulu, (introduced by white Russian immigrants)
Dadant ..	18½″ × 6½″	18½″ × 6½″	Dadant supers in use at Sanjoli (Simla)
Villagers' ..	12″ × 7″	12″ × 7″	Jeolikote Hive 4A
Newton ..	8″ × 5⅛″	8″ × 2⅛″	Introduced by Newton in South India. Specially suited for the plains variety
Travancore ..	12″ × 6″	12″ × 4″	Introduced by Thompson in Travancore

The results of a scientific investigation carried on in Ottawa, Canada, over a period of seven years show that, "the size of hive has little or no influence on wintering or the amount of honey produced. The hive is merely the tool of the beekeeper and with a proper system of management one kind can be made equally as

successful as the other. The Langstroth hive is much more easily manipulated but it is necessary to have two brood chambers."

The Langstroth and Newton frame hives are more in use than other types in India at present. Instructions for making both types are outlined below. It must be emphasized that details of constructions should be rigidly followed to avoid unnecessary annoyance and irritation during use of the hives.

LANGSTROTH TEN-FRAME HIVE

The two-storey Langstroth ten-frame hive consists of the following parts:

1. **Stand.** Any four-legged stand 6″ to 9″ high will do. Its upper dimensions should be such as to support the bottom board properly (Fig. 20).

2. **Bottom Board.** It can be made either by taking a piece of wood 22″ long, 16½″ broad, and 7/8″ thick, or by joining two wooden boards together, nailing them in position with 'wooden rods'. Along each end of the longer side is nailed a 'wooden rod' 22″ long, 7/8″ broad and 7/8″ thick and another 'wooden rod' 14½″ × 7/8″ is nailed at the back. The front is provided with an 'entrance rod' which is 14½″ × 7/8″ × 7/8″ and this has an entrance 3″ long and 3/8″ deep in its middle. Two wooden blocks, to be used for shortening the entrance, when necessary, should also be prepared, each block being 3″ × 1½″ × 7/8″.

3. **Brood Chamber.** It is a rectangular box without top and bottom and is made of 7/8″ thick wood. Its length on the outside is 20″ and on the inside 18½″, its breadth on the outside is 16½″ and on the inside 14½″ and its height is 9½″. A rabbet 5/8″ deep and 1/2″ wide is cut along the entire length of its width planks.

4. **Standard Langstroth Frame.** Consists of a top bar, two side bars and a bottom bar.

(*a*) DIMENSIONS FOR HOFFMAN TYPE OF SELF-SPACING FRAME (FIG. 21).

(i) *Top bar:* 19″ long, 1⅜ wide and 7/8″ thick. It is cut to 3/8″ thickness on both sides for a length of 1-1/16″. It has a groove in the middle of its lower side for fixing the comb foundation sheet.

(ii) *Side bar:* Each is made of 3/8″ thick wood and is 9-1/8″ long. The upper part of each is 1-3/8″ wide and lower

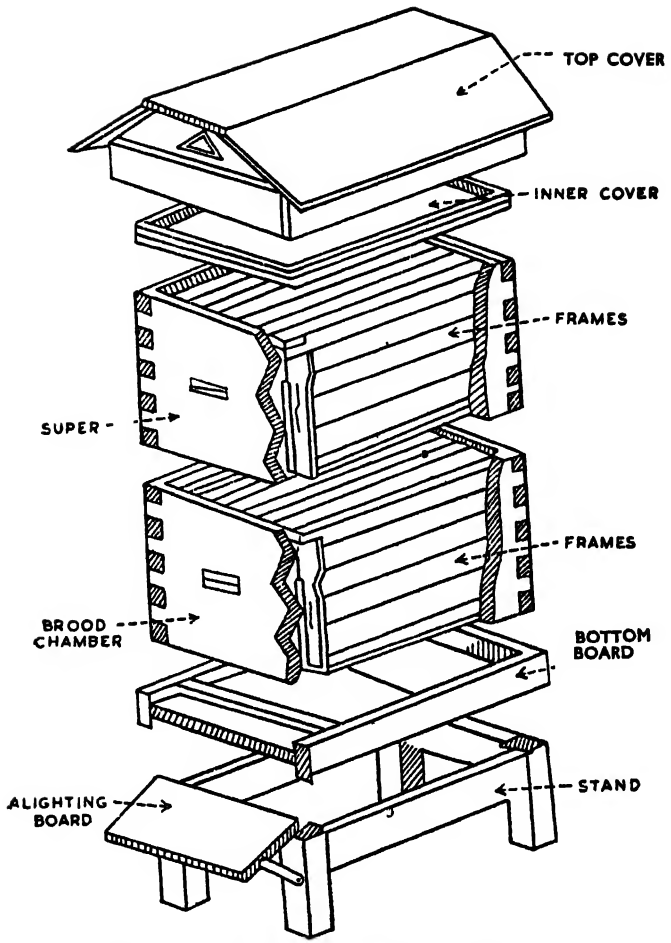


Fig. 20. A two-storey Langstroth ten-frame hive

part 1″ wide. Each is cut out from the middle portion at either end to accommodate the top and the bottom bars respectively. There are 4 holes in each side bar for wiring the frame.

(iii) *Bottom bar:* 17-5/8″ long, 3/4″ wide and 3/8″ thick. The outside measurements of the frame are 17⅝″ ×9-1/8″.

(*b*) DIMENSIONS FOR STAPLE SPACING FRAME (FIG. 22)

(i) *Top bar:* 19″ long, 1″ wide and 7/8″ thick. It is cut to 3/8″ thickness on both sides for a length of 1-1/16″. It has a groove in the middle of its lower side for fixing the comb foundation sheet. It is furnished with metal spacing devices on each end of its opposite faces.

(ii) *Side bar:* Each is made of 3/8″ thick wood and is 8-3/4″ long and 1″ wide. There are 4 holes in each side bar for wiring the frame.

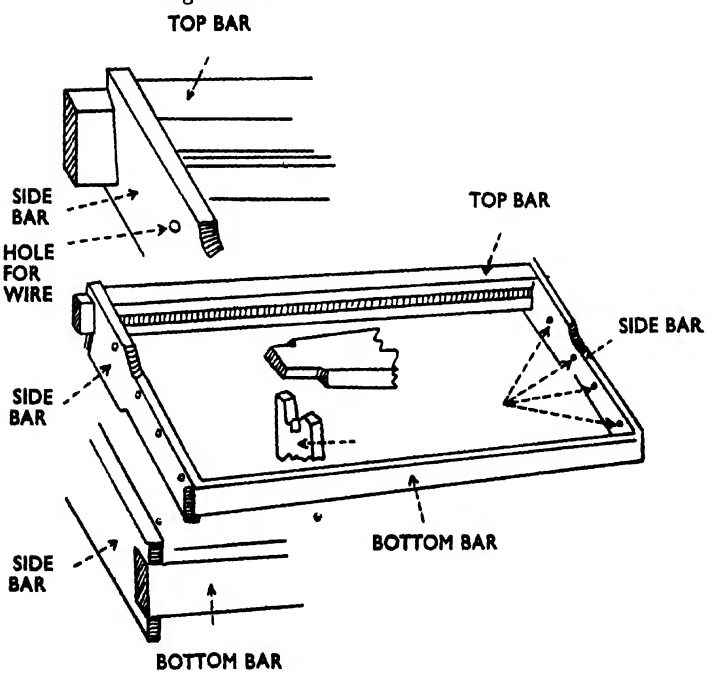


Fig. 21. Details of the Hoffman frame

(iii) *Bottom bar:* It is 16-7/8″ long 1″ wide and 3/8″ thick. The outside measurements of the frame are 17-5/8″ ×9-1/8″.

Two 5/8″ staples should be driven in (to leave only 3/8″ outside) the top bar on its opposite sides so that the frames stand 1-3/8″ apart. One should make all frames either Hoffman or staple-

spaced type. Tinned wire of 28 gauge should be used in wiring the frame.

5. **Super.** The dimensions of the super and the super frames should be the same as those of the brood chamber and the brood-chamber frames, respectively.

6. **Inner Cover.** This is a wooden board to cover the brood-chamber or the super as the case may be. It is 20″ long, 16¼″ broad and 3/8″ thick wood. It has 3/8″ thick and 7/8″ wide 'wooden bar' nailed on to each of its four sides.

7. (*a*) **Sloping Top Cover.** A wooden frame with 20″ × 16¼″ outside measurements is made with eaved sides, and 26″ long slanting boards are nailed on top for the rain water to shed off the sides. The joints should be securely covered over. It rests loosely over the hive.

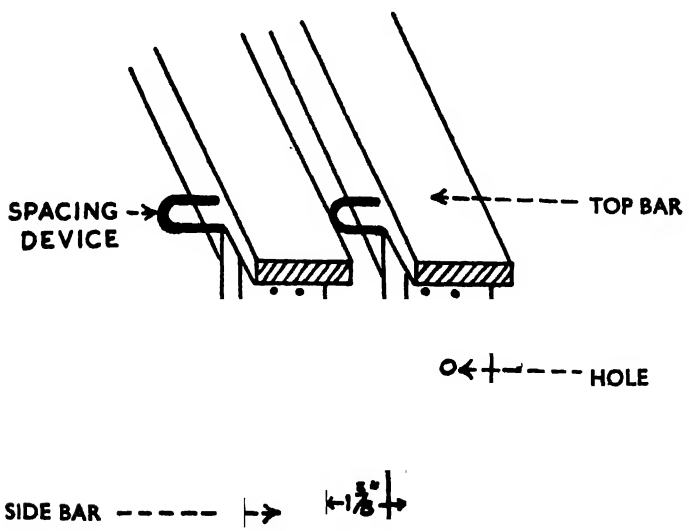


Fig. 22. Details of the staple-spaced frames

(*b*) **Flat Top Cover.** It is made up of 3/8″ thick wooden board nailed to a rectangular frame 2″ high, all covered over with a zinc sheet so as to make it impervious to rain water. Its inside measurements are 21″ × 17″. It also rests loosely over the hive.

Newton hive (Fig. 24) has the following parts [adapted from Ramachandran (1952) and a Bhupen Apiaries' Pamphlet]:

1. **Stand.** A log of wood of about 4″ in diameter and well soaked in solignum is buried deep in the ground. A length of about 9″-12″ is left above ground and a board 16″ × 12″ is fixed on its top with long nails and screws. The hive is placed on this platform on the log.

2. **Bottom Board.** It is a plank slightly wider and 4″ longer than the brood chamber with beadings on three sides into which the hive-body fits in tightly. The extension in the front serves as the alighting board.

3. **Brood Chamber.** It is a box without top and bottom and is made of 7/8″ thick planks with outer dimension 11-1/8″ × 10-1/4″ × 6-3/8″ and inner 9-3/8″ × 9″ × 6-3/8″. Along the top of the front and rear planks a groove of 1/4″ depth and 3/8″ width is made for resting the frames and a clearance of about 1/4″ is provided between the lower extremity of the frames and the bottom board. The front plank has an opening 3½″ × 3/8″ at its lower side to serve as an entrance.

4. **Brood Frame.** Self-spacing (i) Top bar breadth 7/8″, length 10″ and thickness 1/8″ (or 1/4″*) (ii) Side bar height 5-3/4″, width at top 1-1/8″ (or 1-1/4″ *) and width at bottom 1/2″ (iii) Inner length of frame 8¼″, inner height of frame 5⅜″.

An extension of 1/8″ (or 3/16″ *) is given on either side of the side bar and a clearance of 1/4″ (or 3/8″ *) is effected when two frames are kept side by side. There are seven frames in a brood chamber.

5. **Super and Super Frame.** It has the same length and breadth as the brood chamber, but its height is 3-1/8″. The dimensions of the super frame are those of the brood frame but the internal height is 2½″.

6. **Top Cover.** It has two sloping planks on either side. An opening of 3½ inches square, fitted with wire gauze is made on the low ceiling plank to provide ventilation. Two holes on the front and

* Bhupen Apiaries pattern.

The writer urges the use of one size of hive-body as a brood chamber or a super and one size of frame in the brood chamber or super. It is often necessary that frames from one are to be taken out and placed in the other.

rear planks of the top provide the necessary draught. Care should be taken to provide a clearance of about 1/4" between the ceiling plank and the frames below. For the manufacture of hives light, well-seasoned, good-quality timber should be used. The wood should not have a strong smell. 'Kail' (*Pinus excelsa*), teak (*Tectona grandis*) and Toon (*Cedrela toona*) are some of the woods suitable for the purpose. The hives should preferably be painted white or aluminium on the outside to protect the timber from weathering agencies. The hive parts should be accurately cut so that they may be interchangeable throughout the apiary and as emphasized earlier, in the particular part of the country.

Wall Hives. Beekeepers in the hills are used to wall recesses and fight shy of changing over to wooden hives as described in the previous pages because of their innate backwardness. Since the main feature of modern beekeeping is the movable frame, several

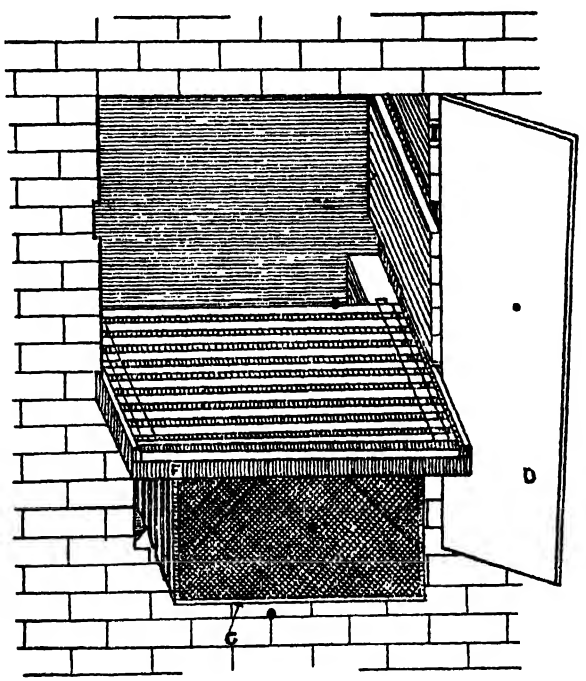


Fig. 23. A wall hive

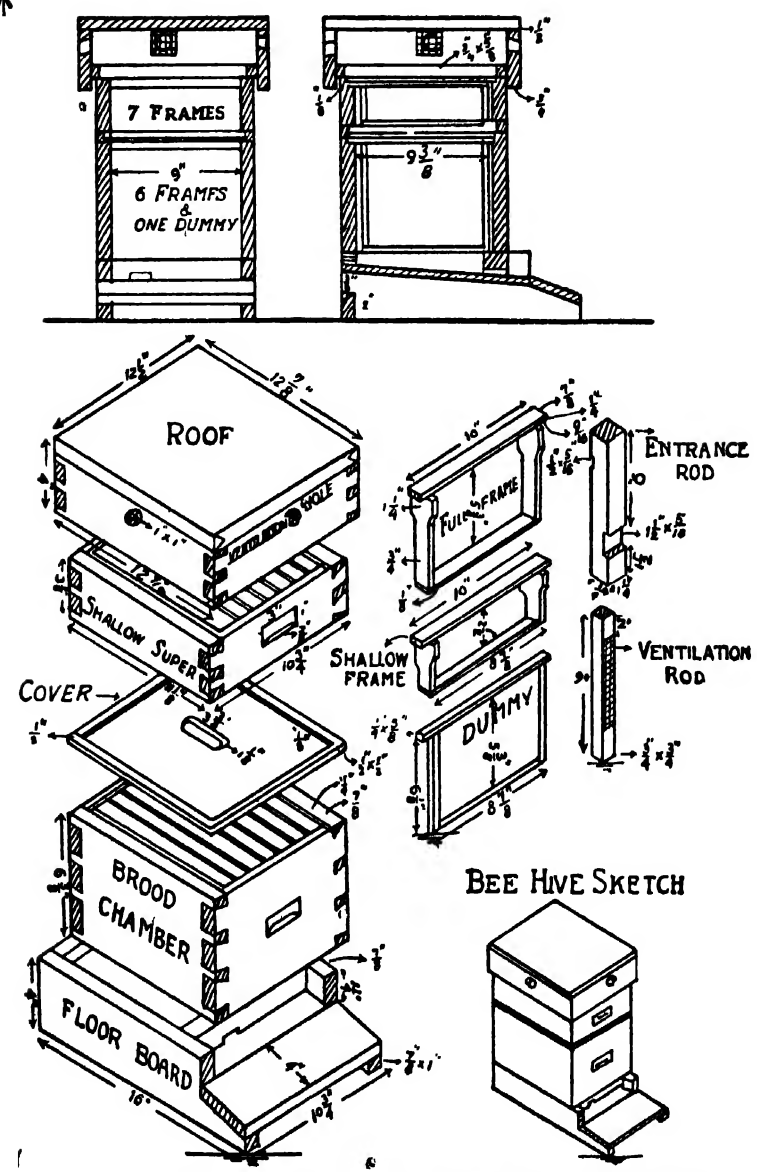


Fig. 24. Details of a Newton hive with super (Bhupen Apiaries)

designs of wall hives with movable frames have been worked out in India with a view to dissuading the villagers from persisting in the old methods and to impress upon them the advantages of the movable frames. One such is shown in Figure 23. Ghosh designed a masonary structure with the combs hanging in a 'comb carrier' frame which could be pulled out for the examination of the combs. He recommended standard British-sized frames. The Jeolikote apiary has designed another with a special sized frame (12″ × 7″) which is expected to suit most of the cavities in Nainital District. Back opening hives in bee houses were a common feature of German beekeeping up to the first quarter of the present century but now-a-days the trend is to use the American type of wooden hives. The advantages and disadvantages of wall hives are given below:

Advantages

1. A large number of colonies can be accommodated in a small area.
2. The walls of the cavities provide ample insulation to the bees and keep the hives cooler during summer and warmer during winter.
3. Interference from cattle, other wild animals and pilferage by unscrupulous persons is eliminated.

Disadvantages

1. It is difficult to handle the bee frames in the dark side of the room. They have to be removed towards light and the chances of a queen getting lost are many. Bright electric bulbs or glass-paned skylights cannot be provided as the bees get attracted to them and exhaust themselves to death. Further, it is difficult to shake the bees from the frames at the entrance of the hive.
2. Bees are more vicious and the operator gets many more stings.
3. The frames which get jammed or glued down are difficult to pry apart and the resulting jerks unnecessarily infuriate the bees.
4. Since the hives are so close together, a little disorganisation in one colony during manipulation creates a furore in the whole apiary. Robbing gets easily started, particularly, during a dearth period.

5. Additional equipment is required for moving colonies from one site to another.

6. It is difficult to keep the hives bee-proof and help the bees, once black ants, termites, wax-moths or other bee-enemies attack them.

7. Excessive ventilation which is required during the honeyflow period (when danger of robbing is very little indeed) cannot be easily provided.

8. Wall hives providing for more than one super become too costly and uneconomical.

9. The placing of the frames in the 'warmway' that is across the direction of the entrance, keeps the hive too warm during the swarming and honeyflow periods.

It will be seen that the disadvantages of the wall hive with movable frames far outweigh its advantages. However, the temporary use of wall hives to impress the villagers of the manifold benefits of the movable frame and modern methods of management should be encouraged, particularly, where the extension workers are unable to make any headway otherwise. Those who have seen the two types of hives working in the same locality will readily take to the wooden type. To facilitate the change-over from wall hives to wooden hives, it is urged that only the two sizes of frames (Langstroth and Newton) should be adopted for wall hives also.

Double-walled Hives. The insulation provided by a single-walled hive is not enough and its inside temperature is liable to fluctuations in response to the atmospheric changes outside. To avoid this the use of a double-walled hive (with sufficient insulation-1½" to 2" on all the six sides), particularly by the novices is recommended (Fig. 26). Such hives are warm in winter and cool in summer and maintain the colonies inside them strong and lead to collection of surplus honey. They do not allow any moisture to condense on the inside of the hives. Double-walled hives are an attempt on the part of the beekeeper to adopt the natural abode of bees—the hollow of a tree trunk—to modern methods of management and are useful houses for bees all the year round. But these hives are rather costly and difficult to handle because of their heaviness and larger bulk.

Comb Foundation. In nature, bees build new combs from

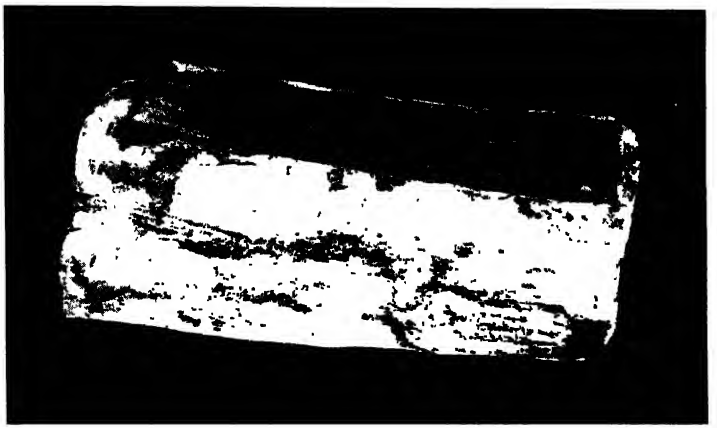


Fig. 25. A hollow log used as an indigenous receptacle for hiving Indian honeybees (Kulu Valley, Punjab)

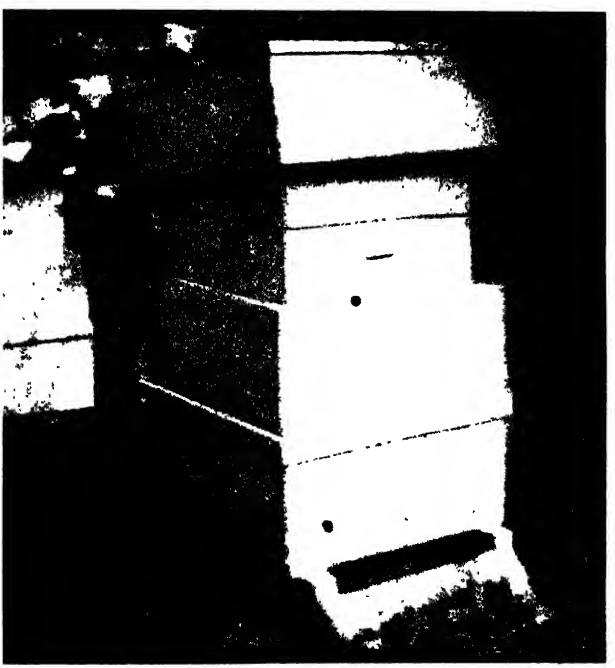


Fig. 26. A double-walled Langstroth hive with supers

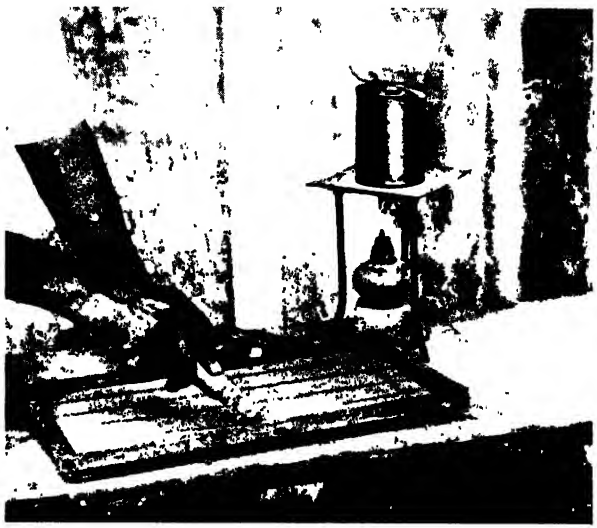


Fig. 27. Embedding a comb foundation sheet in a frame a wire embedding board

Fig. 28. Milling a comb foundation sheet

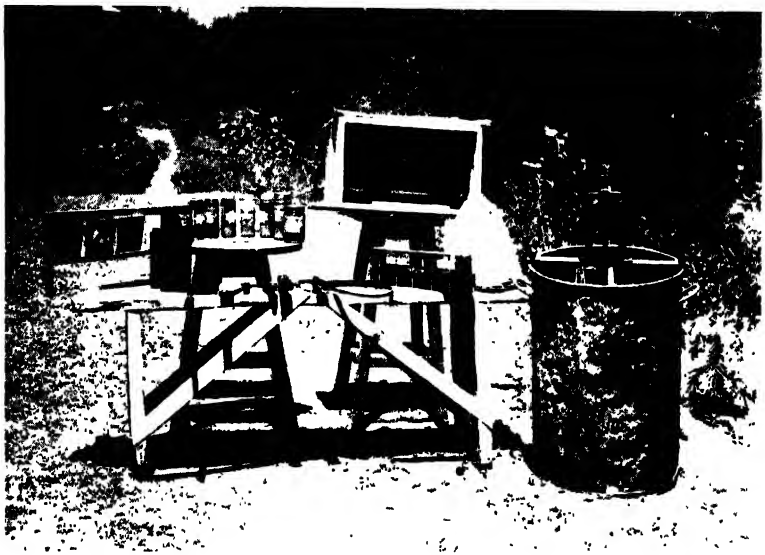


Fig. 29. Honey extractor and some other appliances used in beekeeping

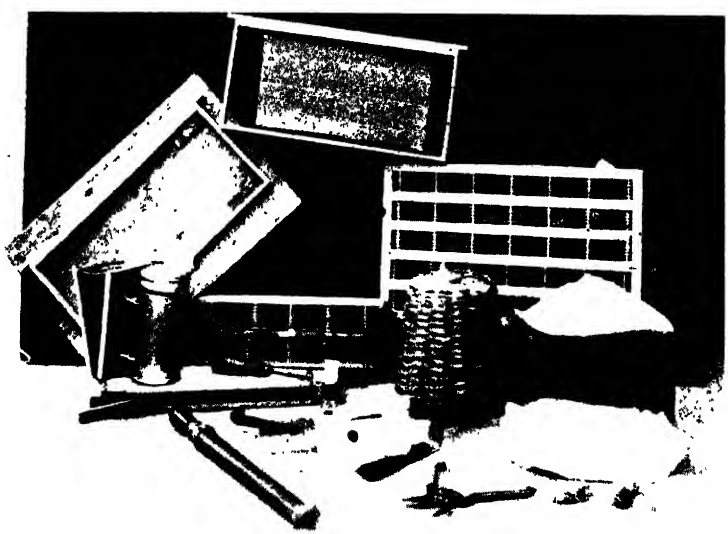


Fig. 30. Some essential equipment Queen excluder, drone trap, veil, hive tool, smoker, syringe, secateur, *tokri*, uncapping knife, division board feeder, wiring board and frame with comb foundation

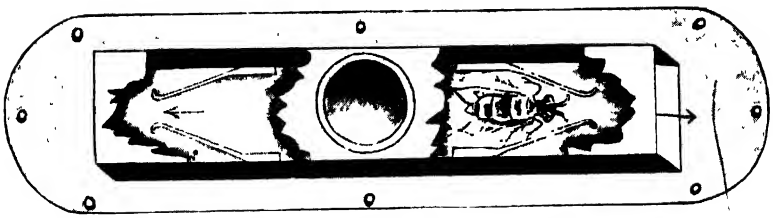


Fig. 31. Porter bee escape—two-way spring type

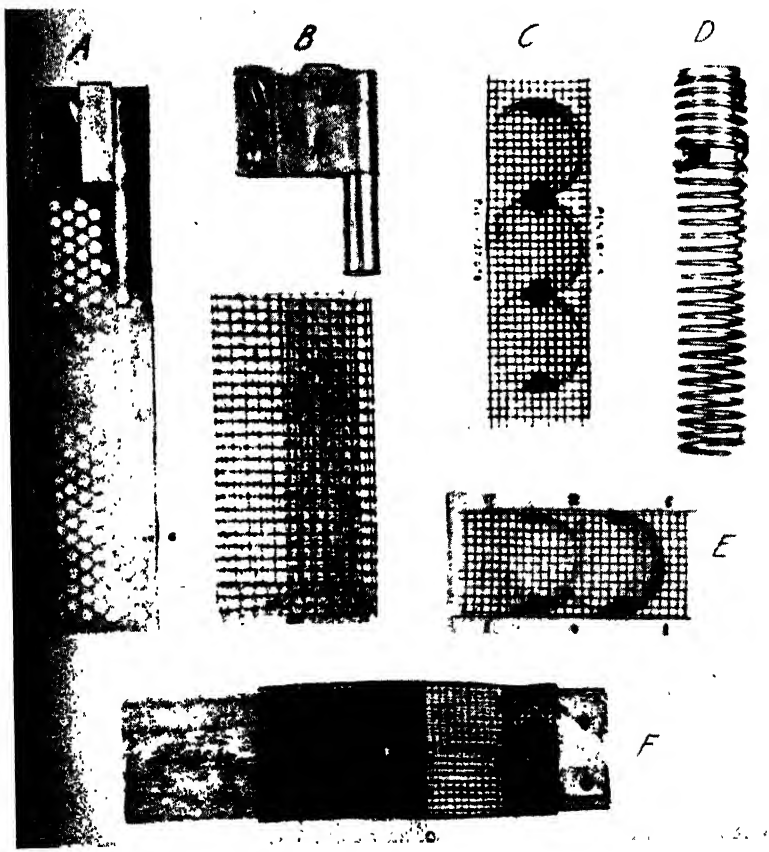


Fig. 32. Different types of queen cages (Eckert)
A, B, C Mailing cages
D, E, F—Introducing cages

beeswax produced by them and make parallel combs which are attached to the ceiling of the cavity or box. The combs may be built in the direction of the entrance, at right angles to it or in an oblique fashion. In the movable frame hive it is imperative that straight combs be built in the frames so that when shifted from hive to hive they may maintain the correct 'bee space' between them. This may be done by fixing sheets of pure beeswax, on which the bases of

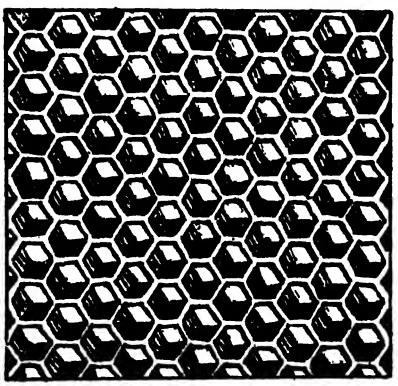


Fig. 33. A piece of comb foundation sheet

worker brood cells are embossed, in the frames (Fig. 28). They are technically called comb foundation sheets (Fig. 33). They are reinforced by fixing horizontal (sometimes vertical) wires (tinned No. 28) in the frames and embedding the same into

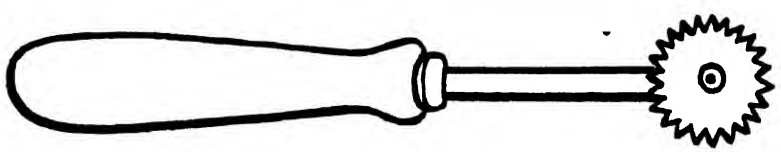


Fig. 34. A spur wire-embedder

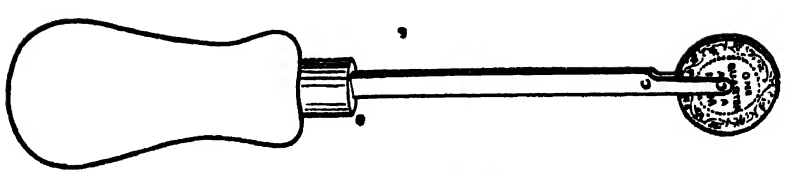


Fig. 35. A pice wire-embedder

comb-foundation on a wire embedding board (Fig. 27) by means of a wire-embedder (Fig. 34 and 35).

As *Apis indica* bees build cells of various sizes in combs in different parts of the country, the use of several types of comb-foundations is indicated. Machines for manufacturing two types are available in the country and the variety of bees (hill or plains with height of the locality above sea level) for which comb foundation is required should be specified when placing an order. Medium brood comb foundation for *Apis indica* bees generally weighs seven sheets to a pound as compared to ten sheets to a pound for *Apis mellifera* bees. Since the size of the single cell is smaller in case of the former, each sheet contains more surface area and a larger number of cell walls.

The combs built on comb foundation are strong and sturdy. Brood combs and combs with honey after 'extraction' of the same can be used for several years and form lasting asset of a modern beekeeper. As stated above, the use of such combs helps one to produce more honey as the bees do not have to build new combs. Besides, in building combs on comb foundation, bees have to add the cell walls only.

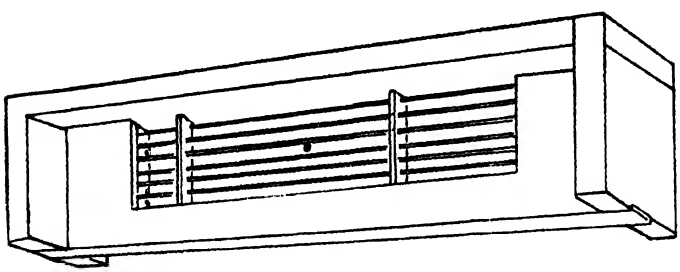


Fig. 36. A wire entrance guard

Queen Excluder. To obtain pure honey free from extraneous matter, it is necessary to separate the brood nest from the surplus honey stores. This is done with the help of queen excluders—which are perforated zinc sheets or round wires assembled together, 0·150″ apart. The workers with their thorax varying from 0·133″

to 0·141″ can easily pass through these perforations but not the queens with their thorax varying from 0·172″ to 0·180″. Since the queen bee is unable to reach the super, the brood nest is limited to the lower hive body, also called the brood chamber.

The wire entrance guard and the drone trap (Figs. 30 and 36) are also based on the principle of the queen excluder. The former restricts the queen inside the hive and the latter after routing the drones into an upper chamber traps them in it.

Honey Extracting Equipment. The honey extractor is a machine with which honey is separated in its purest form from the honey comb. The honey comb is whirled in a cage enclosed in an outside container and honey is thrown out under the centrifugal force and is free from any extraneous matter. The comb is undamaged and can be used again. Various designs of centrifugal honey extractors have been prepared by Fletcher, Thompson, Rahman and Singh, and others and the one most suitable under local conditions may be used (Figs. 29 and 37).

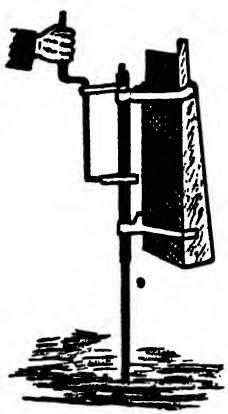


Fig. 37. A simple honey extractor (Fletcher model)

Uncapping Knife. When the cells of the honey comb have been filled, they are hermetically sealed by capping with wax. Before such combs are placed in the honey extractor, these cappings have to be removed with the help of an uncapping knife. A plain steel knife (Fig. 30) or a double jacketed knife heated by steam is used for the purpose.

Equipment For Handling Bees. Bees have stings which they use as weapons of defence. They do not tolerate any outside interference in their home and defend it with their lives. The beekeeper has to examine a colony to find out for himself the condition of the colony and the following equipment is usually required.

(i) SMOKER: It is used to give smoke to the bees for easy handling. It consists of a tin-can provided with a spout for directing the smoke from the smouldering material inside it with the help of a bellows.

(ii) HIVE TOOL: It is a piece of flattened iron with hammered down edges and is used for prying apart the frames in the hive and for scraping bee glue and superfluous pieces of comb from the various parts of the hive.

(iii) OVERALL: It is a protective garment worn over the clothes

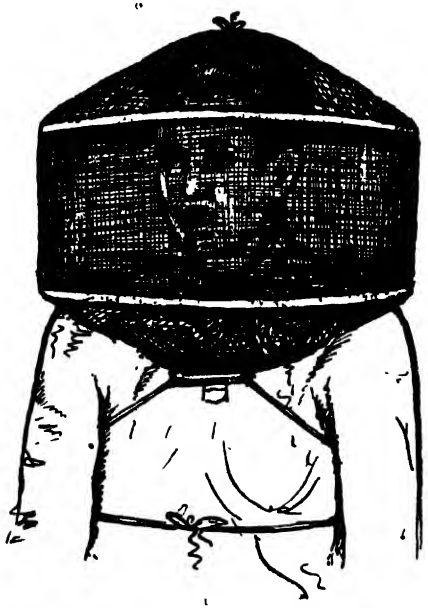


Fig. 38. A bee veil made of wire gauze and cotton cloth

so that bees cannot get under them. Strong cheap white cloth would do.

(iv) BEE VEIL: It is worn over the face for protection against

Fig. 39. A bristle bee brush

stings. It should be made of black light material such as silk, cotton or wire (Fig. 38).

(v) GLOVES: They may be made of heavy canvas or leather and are particularly useful for beginners to develop confidence.

(vi) BEE BRUSH: A bee brush (Fig. 39) or a whisk broom is often employed to brush off bees from a honeycomb before it is taken away for extraction.

Swarm Catching Equipment. Generally swarms settle on

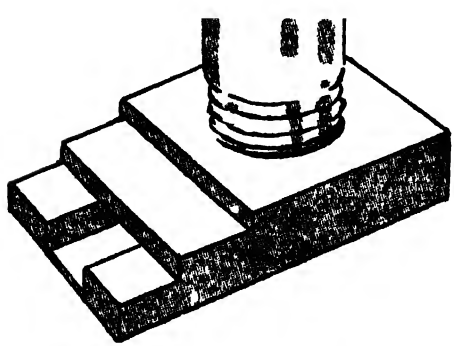


Fig. 40. A Boardman feeder

limbs of nearby trees. If they cluster on a thin branch, it can be gently cut above the swarm by a secateur and taken to the hive. If the swarm has settled on a thick limb it has to be approached and the swarm collected in a swarm-catching basket (Fig. 30) by gently directing the bees into it. Sometimes the bees are shaken into a box which is held on the underside of the limb or caught in a swarm-catching bag from an inaccessible limb. Swarms can be helped in settling down early by sprinkling water into the hovering swarm with the help of a syringe (Fig. 30).

Feeders. Various kinds of feeders for feeding sugar syrup to bees are used by beekeepers. The division board feeder—a wooden trough of the regular Langstroth frame dimensions with shoulders so made that it may hang in the hive just like any other frame and with a wooden strip to serve as a float—is a useful appliance. A

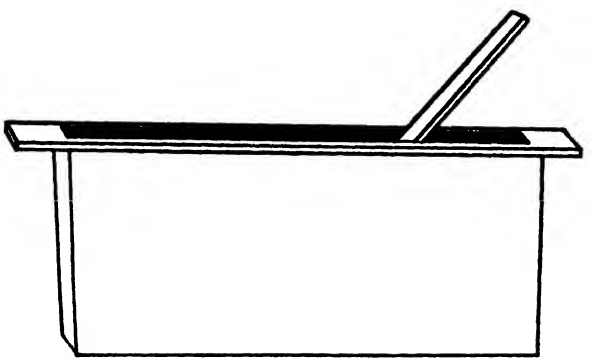


Fig. 41. A division board feeder

lever-lid tin (empty tea tin) with holes in the lid and an inverted glass jar with holes in the lid are also good types of feeders (Figs. 40 and 41).

Queen Cages. Various types of queen cages are in use. The Miller queen introducing cage, the Smith introducing cage, the queen mailing cage and the wire guaze cage are some of the types often used. They are shown in Figs. 42 and 32.

Queen Cell Protector. A queen cell which may have to be introduced from a queen-right to a queenless colony is often protected in a queen cell protector (Fig. 43) until its acceptance by the bees.

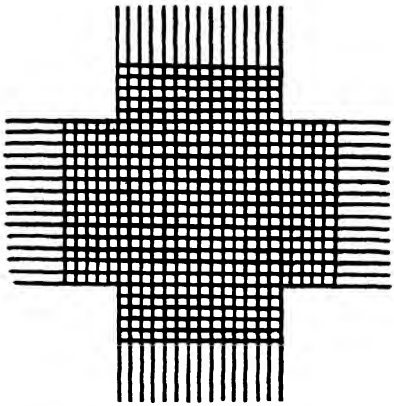


Fig. 42. A wire gauze queen cage

Fig. 43. Queen cell protector

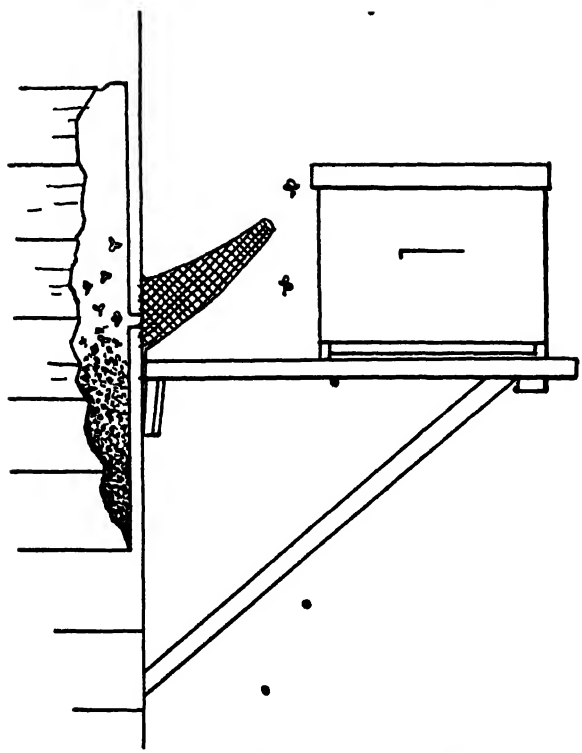


Fig. 44. Diagram of a bee escape

Dummy or Division Board. It is a wooden partition (Fig. 45) which serves as a movable wall and helps to reduce the size of the brood chamber so that bees can keep the hive air-conditioned and well protected from bee-enemies or inclement weather.

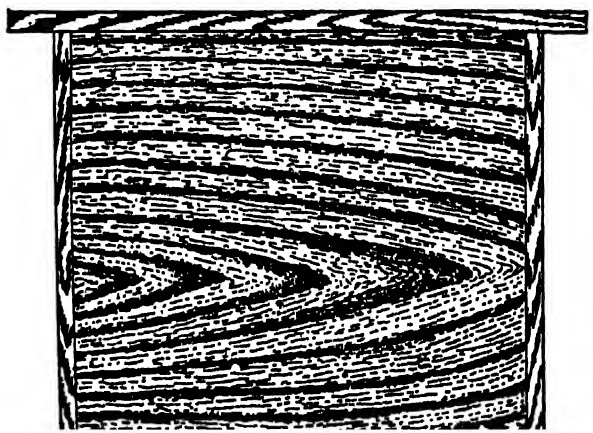


Fig. 45. Dummy or division board

Bee Escape. It is a device for allowing the bees to go through a self-closing exit.

(i) Wire Gauze Cone: It has a broad and a narrow end. The broad end is nailed to a board, etc. (Fig. 44) and the narrow end, which is wide enough to let the bees pass out but not large enough to attract their attention for re-entry, serves as the exit.

(ii) Spring Bee Escape: A pair of delicate springs is so fixed as to allow the bees to push through and make an exit. The springs close the opening by springing back to their original position (Fig. 31).

Often a double bee escape is used in boards which are used for clearing honey supers of bees in them. The boards are placed between the honey supers and brood chambers.

Fig. 46. An Indian honeybees' swarm being hived

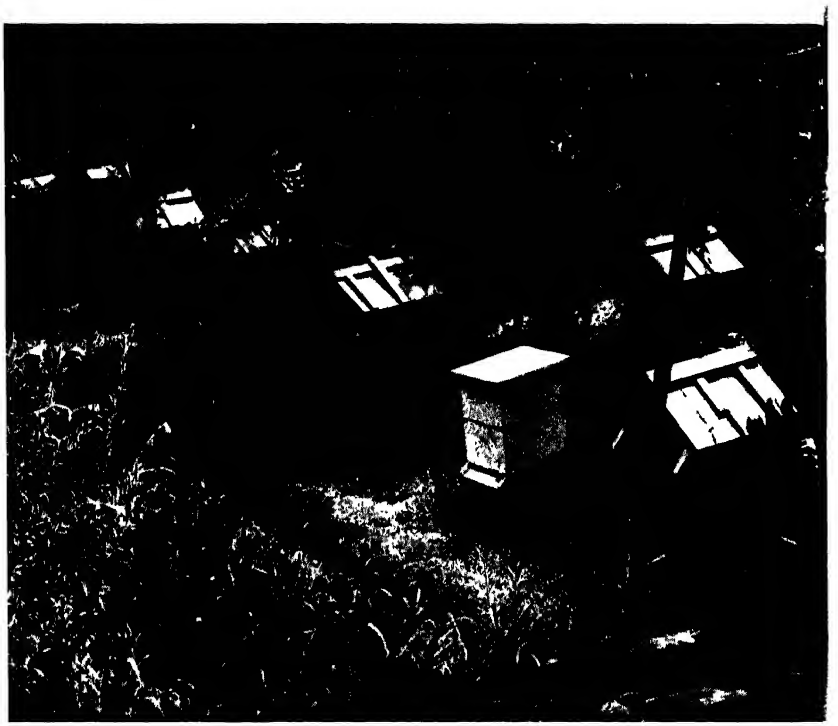


Fig. 47. Government Bee-farm Raison, Kulu, Punjab

CHAPTER 6

HOW TO ACQUIRE BEES

MANY a beekeeper owes his interest in beekeeping to the chance settling of a stray swarm on his property. But many more take to it as a hobby or a cottage industry. Understandably, such people would not wait for the visit of a swarm. Such enthusiasts would rather make special efforts to acquire bees. It is important that the prospective beekeeper should study the subject in advance. A list of books is given in Appendix. If possible he should attend one of the courses in practical beekeeping held annually by Agricultural Departments of several States. Necessary equipment which has been described in the last Chapter can be obtained after the subject has been mastered. Established colonies in modern beehives can be had from a commercial beekeeper or a State apiary. A less expensive method is to buy colonies in box-hives from a zamindar and transfer them to modern hives. Arrangements can also be made for the purchase from local people of stray swarms in the swarming season. To begin with, it is better to have 3 to 5 colonies. The following general instructions are useful for catching and hiving swarms or transferring bee colonies from wall or log hives.

Catching a Swarm. A swarm which has settled on a thick branch of a tree can be collected by placing a basket or a small box open on one side near the cluster and moving the bees gently into it with a leafy twig, or by hand. Smoke can also be used to make the bees enter the receptacle. When a few bees have moved into the basket, the rest will gradually follow. If a swarm has settled on a thin branch, the latter could be gently cut off with a secateur. If the basket or the cut branch has to be carried to some distance, a piece of mosquito netting or cheese cloth should cover the open side of the basket and in the case of branch, it should be wrapped lightly. Sometimes it is possible to shake the swarm directly into the hive having a brood frame. If the swarm has settled in an inaccessible place, it should be unsettled by spraying water with a syringe and made to shift to a better place. Often an insect catching net tied to

the end of a pole is used to catch bees. After enclosing the cluster in the cloth bag, it is quickly drawn towards one side to disengage the swarm into the bag. It is then immediately turned edge-wise preventing the bees from escaping and is lowered down.

Hiving a Swarm. It is advisable to hive the swarm late in the afternoon. In the meantime it should be kept in a cool place. If early hiving is not possible thin sugar syrup should be sprinkled lightly over the bees. It is also important that the bees have ample air. Three to five frames with drawn combs or comb-foundation should be put in a hive placed on the proper site. A frame of capped brood with pollen and honey without any bees should also be given from another colony, if it can spare it. At first a handful of bees should be put into the empty side of the hive and the inner cover placed on it. The rest of the bees should be dumped on an inclined board which lies in front of the entrance. If some of the bees are directed into the entrance with a finger, others will follow. One must see that the queen enters the hive. Two to four lb. of sugar syrup (1 :1) should be fed to the swarm late in the evening. Feeding and the frame of brood help the bees settle down and begin work in their new home.*

Transferring a Colony. The shifting of colonies of bees from old type to modern hives should be done just before the honeyflow season because at this time there is neither much brood nor honey in the colony. It should be avoided in the total dearth period. The transferring should be done preferably in the afternoon.†

(i) FROM A WALL HIVE : After opening the wall hive from the inside, a few puffs of smoke should be given to the bees and the floor of the recess cleaned. The modern hive should be placed near the entrance on the other side of the wall either to one side or below it. With judicious smoking and a handful of green grass, the combs

* When hiving stray and absconded swarms during the drought period, it is advisable to place the wire entrance guard in front of the entrance of the hive for a few days.

† The following equipment is required for the purpose: (1) complete hive with wired frames, (2) two wooden boards of the size of the inner cover (3) an overall, a veil, and a pair of gloves (4) hive tool (5) smoker with fuel (6) match box (7) a sharp knife (8) scissors (9) a chisel (10) a saw (11) a hammer (12) 20 yards of string (13) a queen cage (14) pruning shears (secateur) (15) a rope (16) a pail with water (17) a torch or a kerosene lamp (18) a swarm catching basket (19) a syringe (20) two small pans (21) three pieces of cloth 24" × 18" each.

should be cleaned of bees, cut from their attachments, filled into frames with wires and tied with pieces of string. Such frames with tied combs should be placed in the new hive. The process should be continued until all the combs from the wall hive are transferred. Any big chunks of honey should not be tied to the frames but should either be used in the household or fed to the bees subsequently. When they have settled on the inside wall of the hive, the bees should be put into the new hive by hand or with a cup. The old hive should be closed after all the bees have been transferred.

During the transferring, catching or hiving of a swarm, one should be alert to spot the queen and when spotted the queen should be caught in a queen cage (Fig. 32) and released at the entrance of the new hive so that she may enter. One of her wings may also be clipped.

When the bees have settled in a wall recess which cannot be opened or in the hollow of an old tree which cannot be cut, the only way to salvage bees is by fixing a one-way bee escape at the entrance, closing all chinks and crevices and placing a hive with a brood frame and a queen (in a queen cage) near the entrance of the colony (Fig. 44). After about two to three weeks the cavity may be finally closed and hive removed to the desired site.

(ii) FROM A LOG HIVE: The old type hive may be moved to one side and the new hive should be put in its place. Then the old hive may be opened, smoked, its floor cleaned and turned upside down. The entrance must remain in the same direction. The bees may then be driven off the combs by judicious smoking and tapping the sides of the hive with small stones. The brood combs may then be cut and fixed in the wired frames. Further procedure is the same as described above. This applies also to other movable hives.

The transferred colony may be carried to the new place late in the evening when all the bees have returned home. The bees should be liberally fed with sugar syrup to make them settle down to work. After five to seven days the colony should be examined, the bottom board cleaned, the unwanted strings and misfitting old combs removed. It is also important to add more frames with comb-foundation and check up if the queen is laying eggs at an adequate rate. If life in the colony is running at a low ebb the bees should be fed on sugar syrup.

Colony Inspection. One of the advantages of a modern hive is that a colony can be examined thoroughly to know how the queen is behaving and how much laying she has done. It affords a check-up of uncapped and capped brood, the activities of wax-moth and other enemies and it is easy to have an idea of space requirements of the colonies. The bees' needs can also be met promptly. The beginner is, however, warned against opening the hive oftener than is absolutely necessary for interference upsets the normal working of a colony and sometimes leads to absconding by comparatively weaker colonies during early spring or other periods of inadequate honeyflow. During an inspection as many operations as can be accommodated in a reasonable length of time should be

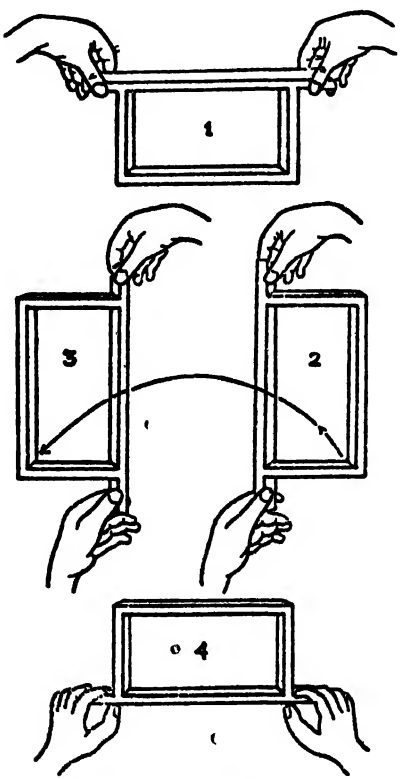


Fig. 48. Manipulating a frame: 1. normal position; 2. held at right angle; 3. after revolving 180 degrees; and 4. the other side of the frame

done. Bright and sunny days, when the bees are working normally, are the safest for this work and the bees should not be disturbed on cold, rainy or windy days or at night. During a visit to the colony the beekeeper should not be profusely perspiring, or strongly smelling of alcohol or horse dung. He should wear an overall and a bee veil (Fig. 38). After lighting the smoker* the hive should be approached from the side to avoid interfering with the bees' flights. A few puffs should be given at the entrance, the inner cover lifted a little with the hive tool, smoke blown into the hive and inner cover dropped in place. After a few moments the inner cover should be removed and placed upside down in front of or against the hive. The frames should be pried apart with the hive tool and taken out and examined one by one. They should stand in a vertical position and preferably over the hive. For examining the other side of the comb, it should be manipulated as shown in Figure 48. During these manipulations, the queen should always be kept in mind and the frame on which she is located should be placed back in the hive early. The frames should be handled gently and jerking and crushing of the bees must be avoided so that they are not provoked to sting. Apart from the stings being painful, the odour of the poison irritates the bees and makes them difficult to be managed. If stung, the sharp edge of a hive tool or a finger nail should be used to take out the sting quickly to reduce poisoning. It is wrong to squeeze it out with finger tips. The spot should be washed well in water. Rubbing the wound only aggravates irritation. A few persons (particularly women) if stung by even a single bee develop rashes all over the body and have difficulty in breathing. They should not go near an apiary. The vast majority, however, feel pain for a few minutes and the local swelling diminishes with succeeding stings. Eventually they become immune.

After the examination of the colony has been completed and other operations carried out, the colony should be closed tightly without leaving any chinks and crevices.

Location of Apiary. Often a would-be beekeeper who must

* Rags, oily cotton waste, wood shavings, dried cowdung, maize cobs, pine cones, rotten wood, dry leaves, etc. make good fuel for a smoker. A bee veil is always useful and the habit of some beekeepers to "show off" in handling bees without a veil is to be disocuraged. Such a practice often results in a swollen eye or a portruding lip.

remain in his native place has no choice of a place for keeping his bees. However, in many other cases he is in a position to select one out of the several places for his apiary. The main points which require consideration are outlined in Chapter 7. In general, an apiary should be located at a site which has an abundance of nectar and pollen plants within a one-mile radius. Besides, the site should not be exposed to strong winds. At least the hives should not face the direction of the prevailing winds. Trees, bushes or trellis work may be provided in a locality to make it less windy. On the other hand, it should be sufficiently airy and stuffy places avoided. The site should preferably be flat with a general slope for drainage of rain water. Marshy lands or those subject to floods should be avoided. Clean and fresh running water should be available to the bees in or near the apiary. Without it the bees would visit polluted and stagnant ponds or cause annoyance to neighbours. A shady place is very good for an apiary, but a young orchard is an ideal choice. However, one should avoid thick groves of tall trees where the air often becomes stagnant and the atmosphere is close and muggy on hot days. In an exposed and treeless area, an open shed with a thatching of dry grass may be erected to provide shade to the bees.

An apiary should be easily accessible by road or rail but the bees should not be housed too near a highway for their sake and also for the sake of people who use that road. A good barbed-wire fence or wooden boards or a hedge of a thorny plant should be put up to keep out intruders of all kinds, men or animals. Like all busy creatures bees dislike to be disturbed.

The site should be kept free from black ants and termite infestations by undertaking periodic campaigns against them. Hive stands should be impregnated with solignum.

It is desirable to locate an apiary in a valley at a lower height because the upward journey to flower patches will be made by bees when they are light and they can 'coast down' when their bellies are full.

Arrangement in Apiary. About 50 to 100 colonies may be kept in one apiary, according to the amount of space available. They may be placed from 6′ to 10′ apart in rows and the rows should be spaced from 10′ to 20′ to give ample room to the beekeeper to work. Moreover, if the colonies are too near any

TABLE 4. SUNSHINE APIARIES—RAISON, KULU

Colony No. 23—A Sample Page from a Colony Ledger

Primary swarm from colony No. 7, date 15.4.53, 11 A.M. weighing 3½ lb., hived at 5-30 P. M., with one frame capped and uncapped brood, one frame pollen and honey, 4 frames drawn combs and 2 frames with comb-foundation; 5 lb. of sugar syrup fed.

Date of examination	No. of frames		Area in sq. inches (estimated)			Freshly laid eggs present	Working of queen (Good-G Satisfactory-S Poor-P)	Remarks	Work to be done	When "work to be done" completed.	Initials
	Covered by bees	With brood	Brood	Pollen	Honey						
15·4·53	*Hived* 5-30 *P.M.* 5 *lb. food given*										
18·4·53	6	1	60	20	150	Yes	G				GR
28·4·53	6	3	250	100	350	Yes	G	R. Ws. of queen clipped	..	..	GR
7·5·53	7	4	350	150	500	Yes	S				BL
									Give drawn frame-congestion	2 drawn frames I.C.F. frame given 7-5-53	GR

commotion in one would cause disturbance in others. In case, there is shortage of space, colonies can also be placed in groups of two or four. In a large apiary too much uniformity in the placement of hives is not good. Landmarks like bushes, trees, etc. may be placed at suitable intervals to help the homing bees recognise their hives. Amateur beekeepers may place the colonies in the verandahs and on the flat roofs of their houses or under trees in the backyard.

The hives should be placed on stands about 9″ to 12″ high. They should be level from side to side so that the combs in the frames are built vertically downwards. There should be a slight back to front incline so that excess of moisture may be drained out and it should be easy for the bees to throw out the *debris*.

The hives should preferably face the east because in this way bees may start their work earlier in the morning and the entrances are not exposed to mid-day sun. The line of flight of the bees should not interfere with a public path or a neighbour's playground. If it does, tall boards may be put up just away from the entrances of the hives to suitably deflect their flights.

Colony Records. Every colony should bear a detachable number and colony record kept in a ledger. A sample page from such a ledger is given in Table 4. Certain beekeepers have devised various signs in the form of coloured blocks, sticks, etc. which are placed on the colonies for attracting the attention of the beekeeper to the needy ones while he is on a round of the apiary. A plan suited to local requirements can be worked out.

Another desirable thing in an apiary is a platform balance to weigh an above-average colony every night when all the bees have returned home. Daily recordings of weight show trends of the honeyflow and help the beekeeper adjust his plans to the needs. Meteorological data, obtained from a local meteorological station or collected daily by the beekeeper himself are useful in forecasting the course of a honeyflow.

Out-Apiaries. In view of the fact that a location can support from 50 to 100 colonies normally, it is necessary for commercial beekeepers to establish several apiaries in the surroundings of the home apiary. Such apiaries are called out-apiaries and beekeepers visit them periodically. The colonies in the home apiary have to be watched carefully to arrange timely visits to the out-apiaries.

Out-apiaries are useful in discovering more suitable sites which may yield larger output per colony and the beekeeper may eventually like to shift his enterprise to the new area.

CHAPTER 7

BEE PASTURAGE

HONEYBEES gather nectar and pollen from plants as their food. Nectar, a sweet secretion from the floral and extra-floral nectaries of blossoms is the raw material of honey. Pollen is a highly proteinaceous food for bees. The plants that yield these two substances are collectively termed 'bee pasturage', 'bee forage' or 'nectar and pollen plants'. The days when a good number of plants have nectar to be foraged by honeybees is called a honeyflow period. If the nectar yield is copious from a good number of the plants of a particular species it is called a major honeyflow period. When the amount of nectar to be collected is small the period is called a minor honeyflow. The days when there is no honeyflow is called a 'dearth period'. As nectar and pollen are the raw materials of the beekeeping industry a thorough knowledge of the honey and pollen plants of a locality and the conditions that govern the production of the two substances are of paramount importance.

It is interesting to note that the relationship between honeybees and plants is on a give and take basis. Many plants require the visits of insects for cross-pollination. To attract the insects they secrete nectar and have some highly coloured blossom parts (corolla). Insects in their search for nectar, go over the flowers thoroughly. In this process pollen grains get stuck among their branched pubescence. Every few minutes the bees remove pollen from their bodies with pollen brushes and collect surplus pollen in their baskets. Whereas honeybees help bring the male and female parts of flowers together and thus arrange fertilization of the ovum, the blossoms give them nectar and pollen to eat. The bees make honey from nectar only and not pollen.

Not all blossoms are visited by bees and some of those which are, may be insignificant. A beekeeper who wants to know the nectar potentialities of a locality must ask himself the following questions:

1. What blossoming plants are found in abundance in one or two-mile radius of the locality where he wants to keep honeybees ?

2. How long are their blossoming periods ?
3. Are the flowers visited by honeybees for nectar or pollen or both ?
4. Are bees able to collect surplus honey from some abundant crops of flowers year after year ?
5. What are the nectar-secreting and flowering plants besides the major crops of the area ?
6. How long a dearth period, if any, lasts ?

On the answers to these questions will depend the suitability or otherwise of the locality for beekeeping. If nectar-secreting plants are available in large numbers, that is, there are one or two major honeyflow periods with minor honeyflow periods during other parts of the year and the dearth period is not of a long duration, then beekeeping can be successful in that locality. For example, the Kulu Valley in the Punjab is, in general, suitable for beekeeping because there are major honeyflows in spring and autumn from fruit bloom and barberry and *Plectranthus* respectively. The dearth period in summer (mid-June to mid-August) is not long and the winter dearth period coincides with the coldest part of the year when bees are inactive otherwise. Similarly, in the Kangra Valley in the Punjab, round the year beekeeping is possible because there are a major honeyflow in the spring, an average honeyflow during the comparatively milder winter and minor honeyflows off and on in the otherwise long dearth period. It is not so in the plains of the Punjab. Though major honeyflows in winter and spring are experienced, there is a long dearth period from mid-May to mid-November when in addition to a lack of food in the fields, the bees have to face bigger hordes of enemies, namely, wasps, ants, wax-moths, bee-eaters, etc. The above three examples broadly explain what is meant by 'suitability for beekeeping', as far as supply of nectar and pollen goes. Of course, there are other considerations. If a particular locality is bereft of wild or cultivated honey plants and is overgrown, for example, with tea bushes and pine (*Pinus longifolia* Roxb.) trees it will obviously be unfit for establishing an apiary.

It is easy to distinguish pollen-yielding plants by examining the metathoracic-legs of honeybees. If they are returning from such plants their pollen baskets will be filled with pollen pellets. As the nectaries of blossoms are deep-seated and too small to be seen with the naked

eye, it is usual to examine the contents of the honey-stomach of a foraging bee. Such a bee is held by the wings and the anterior region of its abdomen is pressed. Generally, there is a drop of a glistening liquid at the top of its tongue. It is tasted. If it is sweet, the bee has been collecting nectar. Alternatively, the drop is taken on a piece of filter paper and allowed to dry. If a shining spot is left, the liquid contained dissolved matter and is apparently nectar collected from blossoms. If no spot is left, the liquid is plain water. Often a bee carries a little honey in its honey-stomach from the hive for moistening the dry pollen of wind-pollinated plants like maize, *cholam* (*Sorghum vulgare*), etc. so that the same can be packed tight and held in their pollen baskets. If so, the bee brings out the drop of liquid with very great difficulty and moreover, it is very thick. If several foraging bees are examined, there will be no difficulty in deciding whether or not the blossoms are yielding nectar.

Some plants yield only nectar, others only pollen and still others both. Lists of plants classifying them as major and minor sources of nectar and pollen have been published by several States. In the following pages important plants are classified according to their economic and botanical status.

Fruits. In India large blocks of fruit trees are not common and hence pure crops of honey from many of the fruit plants are not possible. Besides, bee colonies usually are not in full strength at the time of fruit bloom and the nectar and pollen obtained is enough only for brood rearing and reserves. There is no surplus for the beekeeper. Descriptions of some of the important fruit plants are given below:

BANANA (*Musa paradisiaca* L., *Musa nana* Lour., and *Musa sapientum* L—Musaceae). These stout perennial herbs are grown for their fruit all over India. *Musa* spp. flower throughout the year and are visited by bees for both nectar and pollen. Since the number of plants flowering at a time is not high, *Musa* spp. are, at best, a minor source.

BERRIES (*Rubus* spp.; Rosaceae; *akhan, akhe*). Berries or brambles are perennial woody shrubs with spines or bristles and grow wild in hedges, on borders of fields and as forest undergrowth in the hilly tracts from 2,000 to 9,000 feet above sea level throughout India. Cultivated varieties are often met with. They produce

white, whitish or greenish flowers from March to May and are much frequented by bees for both pollen and nectar which they produce abundantly. They help the bees in brood rearing and occassionally in laying by some surplus stores.

The numerous pistils are fleshy in fruit and crowded together upon a spongy receptacle. They are usually named after the colour of their fruit as black berry, blue berry, red raspberry, etc. The berries have their characteristic flavour and are good to eat.

CITRUS FRUITS (*Citrus* spp. Rutaceae; *sangtra, malta, mosambi, nimbu, meetha, galgal*). Most of these fruit trees are grown throughout India and yield abundant quantities of both pollen and nectar to the bees. They blossom in the spring and are very helpful in early brood rearing. In localities where the area under citrus orchards is large, some surplus honey is stored by bee colonies. A surplus honey crop from citrus is not possible in most localities in India but is a common occurrence in California (Fig. 52).

COCONUT (*Cocos nucifera* L.; Palmae; *narial, khopa, gola, narikel*). It is a tall majestic palm cultivated in the coastal regions. It blooms in May or June and bees collect abundant pollen from the staminate flowers in spathes. Collection of nectar from this source has not been reported from anywhere in India though along the east coast of Florida, it is considered to be an excellent source.

WILD DATE-PALM (*Phoenix sylvestris* Roxb. Palmae; *khajur, khaji*). It is a wild palm of Indian origin with variable structure in different localities. It produces male and female flowers in separate spathes. The male spathes blossom in summer (August) and bees collect pollen of which it is a good source. It is also used for tapping toddy and making sugar.

The cultivated date-palm, *Phoenix dactylifera* L. has been introduced in some parts of the country as an avenue tree and for its delicious fruit.

Temperate Zone Fruit Trees. *Malus, Pyrus, Prunus* and *Cydonia* spp. Rosaceae; *seb, nashpati, aru, alucha, khurmani, badam, bihi.* Different varieties of apples (Figs. 50 and 81), pears, plums, peaches, apricots, cherries, almonds, quinces and their closely allied wild species are included in this category. Distribution of such fruit trees and their wild relations is very much restricted in India and these trees are of local importance as honey and pollen plants.

They blossom in spring (February to April) and bees gather both nectar and pollen from them. They are very helpful plants to bees as they bloom at a critical period during the life of a colony and encourage brood rearing in spring.

Surplus honey is known to have been occasionally gathered from apple blossoms in the Kulu Valley and *pajja* (wild cherry)—*Prunus cerasoides* D. Don (—*P. puddum* Roxb.) in the Kangra Valley. The former blossoms in April and the latter in November.

GUAVA (*Psidium guajava* L.; Myrtaceae, *amrud*). It is a small fruit tree and is cultivated throughout India up to a height of 3,500 feet above sea level. It bears large white blossoms in May and June and yields nectar and pollen. Some beekeepers report that guava is a source of nectar only whereas others believe it to be a source of pollen.

JAMBOLAN: (*Syzygium cumini* Skeels and *S. fruticosum* Roxb. Myrtaceae: *jaman, jangli jaman*). It is a large evergreen avenue and fruit tree found throughout India. Its dirty white flowers are mostly arranged in threes in panicles usually below the leaves. It blossoms in April or May, the honeyflow extending over a period of two to three weeks. It yields surplus honey in some localities.

JUJUBE (*Zizyphus mauritiana* Lam.; Rhamnaceae). It is a cultivated tree grown for its fruit in gardens. It blooms in July or September and is occasionally visited by bees for pollen and nectar. It is at best a minor source.

MALLAH (*Z. oxyphylla* Edgew). It is a wild shrub very common in dry localities and is occasionally visited by bees for pollen and nectar.

LOQUAT (*Eriobotrya japonica* Lindl.; *lokat*, Rosaceae). It is a small evergreen fruit tree, introduced from Japan into India and is widely cultivated. It bears white fragrant flowers in terminal panicles early in spring (February-March). There is a second flush flowering occasionally during the monsoons, i.e. August. It is visited by bees for nectar but is a minor source.

MANGO (*Mangifera indica* L.; Anacardiaceae, *am*). It is a large evergreen tree widely met with throughout India. It bears yellowish green flowers in terminal panicles. About one-fourth of the flowers are bisexual and the rest are staminate. Since the pollen grains are sticky in nature, insect pollinators are essential. Bees gather

both nectar and pollen, but it is an erratic yielder and no surplus crops of honey are reported from this source.

Bees also collect honeydew from mangoes during different seasons and suck the sweet juices of over-ripe fruit.

PHALSA (*Grewia asiatica* L., Tiliaceae). Probably this shrub which is grown for its fruit, is the cultivated form of *G. subinaequalis* DG. It blooms from April to August and yields nectar to the bees. It is a minor source.

BEOL (*Grewia oppositifolia* Roxb). It is a medium-sized tree which is frequently planted for lopping its foliage for fodder, for its bast fibre for ropes and its timber for axe handles, oars and poles. It blooms in April or May and yields nectar, but mostly it is not allowed to flower as it is heavily lopped for fodder.

POMEGRANATE (*Punica granatum* L.; Punicaceae; *anar, dalim.*) It is a large deciduous shrub or small tree and is met with as a wild plant from 3,000 to 6,000 feet above sea level. Selected varieties are grown throughout India on a small scale. It produces large red flowers and yields abundant quantities of pollen.

CASHEW (*Anacardium occidentale* L.,—Anacardiaceae) grapes (*Vitis vinifera* L.; Vitaceae), papaya (*Carica papaya* L.; Caricaceae), sapota (*Achras zapota* L.; Sapotaceae) and sweetsop (*Annona squamosa* L.; Annonaceae) are introduced fruits grown in many parts of India and yield small quantities of pollen and nectar.

Vegetables. Generally, vegetables are, even at best, minor sources of pollen and nectar because most of them put forth blossoms over prolonged periods and their small plots are scattered over large areas. However, they perform a valuable role as minor nectar and pollen plants because they keep the bees busy in the fields and are, at certain times of the year, the only plants in bloom in an otherwise total dearth period.

CARROT (*Daucus carota* L., Umbelliferae; *gajar*). This vegetable is allowed to flower only when seed is to be obtained and as such the area under it is not large. It blossoms in March-April and yields nectar and some pollen. It is a very minor source.

CORIANDER (*Coriandrum sativum* L., Umbelliferae). It is grown throughout India as a green or dry condiment. It blooms from February to May and is visited by bees for nectar and pollen. In

the absence of a better source bees make eager visits to its blossoms for nectar and pollen. It is a minor source.

CRUCIFEROUS VEGETABLES (*Brassica* spp.; *turnips*, *sarson*, *rai*, cauliflower, cabbage, knol khol, brussels sprout Cruciferae). These vegetables are grown all over India but are not allowed to put forth blossoms except where seed formation is desirable. They yield both nectar and pollen from December to March, but play a very minor role as bee plants (see also 'crops' section). Cress, *Lepidium sativum* L. has not been seen being visited by bees.

CUCURBITACEOUS VEGETABLES (*Trichosanthes*, *Benincasa*, *Cucurbita*, *Cucumis*, *Citrullus*, *Lagenaria*, *Momordica*, *Luffa* spp.; gourds, melons, *tinda*, *karela*, *tori*, cucumber, etc. Cucurbitaceae). More than a dozen species of cucurbits are grown in patches of varying sizes throughout India and they blossom almost throughout the year except in severely cold weather. They supply both nectar and pollen, but are not known to yield any surplus honey as their area in a locality is small and their flowering period spreads over a long time. However, they are useful stand-bys during a dearth period.

FENNEL (*Foeniculum vulgare* Mill., Umbelliferae). Fennel and dill (*Anethum graveolens* L.) are grown on a small scale all over India and are visited by bees for nectar and pollen from January to April. They are a minor source.

LADY'S FINGER (*Abelmoschus esculentus* L.; *bhindi*, Malvaceae); This vegetable is grown all over India extensively and flowers during summer and the monsoon. It yields both pollen and nectar but is only a minor source.

An ornamental—*Hibiscus mutabilis* L. is also visited by bees for nectar and pollen and is a minor source.

ONION (*Allium cepa* L.; *piaz*; Liliaceae). Ordinarily it is not allowed to flower, but large onion fields and the areas left to seed often have these blossoms in May to June. Bees visit it for both nectar and pollen. Under favourable conditions it secretes nectar freely.

GARLIC (*Allium sativum* L.) It behaves similarly. A wild species—*Allium rubellum* Bieb. is also visited by bees for pollen and nectar.

PEAS (*Pisum sativum*, *P. arvense* L.; garden pea, field pea. Leguminosae). These are grown all over India in vegetable gardens, in fields and as ornamentals. They are not visited by bees.

Fig. 49 Government Bee-farm Nagrota, Kangra, Punjab

Fig 50. A colony of bees in a blooming apple orchard (Phillips)

A few cases are in record in Canada where bees collected a crop of honey from garden peas. *Lathyrus sativus* L. (Climbing vetch, *charal*) is grown for fodder and blossoms from January to March. It is occasionally visited by bees for pollen. Sweet pea (*Lathyrus odoratus* L.) has not been noticed to be visited by bees.

RADISH (*Raphanus sativus* L.; *muli*, *mongra*, Cruciferae). This vegetable is grown throughout India but is not allowed to flower except for seed or when pods are used as a vegetable. It blooms from December to March and yields small amount of nectar and pollen.

A wild species *gougla* (*Raphanus raphanistrum* L.) is met with as a weed in wheat fields and is occasionally visited by bees for both nectar and pollen, but is a very minor source.

SPINACH (*Spinacia oleracea* L.; Chenopodiaceae). This vegetable is not normally allowed to flower except when reserved for seed. It flowers early in summer and is rarely visited by bees for pollen.

BEET ROOT (*Beta vulgaris* L.) is not known to be visited by bees. Indian Spinach-*Basella alba* L. and *B. rubra* L. are also not visited by bees.

SWEET POTATO (*Ipomoea batatas* Lam. Convolvulaceae. *shakar kandi*). This root crop is extensively grown all over India. It blossoms during the winter in South India and bees collect pollen from it. It is a minor source.

RAILWAY CREEPER (*Ipomoea pulchella* Roth). It is an exotic climber, cultivated all over India. It is visited by bees for both pollen and nectar and is a minor source.

BRINJAL (*Solanum melongena* L.), potato (*S.tuberosum* L.), tomato (*Lycopersicon esculentum* Mill.), chillies (*Capsicum* spp.) and other wild species of *Solanum* (all belong to family Solanaceae) are rarely if ever visited by bees for pollen.

LETTUCE (*Lactuca sativa* L.) and some wild varieties of *Lactuca* (Compositae) are not known to be visited by bees.

ORNAMENTALS. Ornamental plants are, generally, too few in a locality to act as major sources of nectar or pollen, but avenue trees sometimes are responsible for surplus honey yields. In their own way, ornamentals are useful to bees particularly during a dearth period. As listed below quite a large number of ornamentals are not frequented by bees.

AGERATUM (*Ageratum conyzoides* L.; Compositae). It is an erect annual, grown all over India in gardens. A wild variety is commonly met with along water channels and in the fields. It has light blue flowers during the monsoons and is a minor source of pollen to the bees.

ASTER (*Aster thomsoni* C. B. Clarke; Compositae). It is an erect and branched herb with purple flowers which appear in autumn and yield both nectar and pollen.

Many ornamental asters (prominent among which is *Callistephus chinensis* Nees.) are grown in gardens and they supply both pollen and nectar. *Aster novibelgi* L. is a perennial and hardy herb which bears blue flowers in late autumn (September to November) and is eagerly visited by bees for pollen and nectar.

CORN FLOWER (*Centaurea cyanus* L.; Compositae). It is a hardy annual with beautiful blue flowers. It blossoms in spring from February to April and bees eagerly visit it for nectar and also collect some pollen. It is a useful plant and can stand adverse conditions.

CORAL CREEPER (*Antigonon leptopus* Hook. and Arn.; Polygonaceae). It is large evergreen vine which climbs by means of tendrils. It is a much cultivated plant in gardens for arbours and trellises or for covering verandahs. It flowers from early summer to late autumn and bees visit it for nectar and pollen. It is an important source where the area under it is large.

COSMOS (*Cosmos sulphureus* Cav.; Compositae). It is a hardy annual which requires little care and is grown in various seasons in different localities. Sowings which blossom in autumn (September to October) yield fair amounts of nectar and pollen. At other times its blossoms are disregarded by bees.

GUL MOHR (*Delonix regia* Raf.; Leguminosae). It is an introduced tree from Madagascar and is cultivated as an avenue tree. It blossoms from May to June and yields pollen.

VADANARAYAN (*D. elata* Gamble). It blooms in March and yields pollen.

GOLDENROD (*Solidago longifolia* Schrad; Compositae). It is a perennial herb and is used as a border plant for flower beds. It blossoms in autumn and supplies both nectar and pollen. In the plains it comes during the severe dearth period when bees are prone to abscond. Several wild species of goldenrod are also met with.

HOLLYHOCK (*Althaea rosea* Cav.; Malvaceae; *gul khaira*). It is a herbaceous biennial or perennial flowering plant grown in gardens throughout India. It flowers in spring and summer and yields both nectar and pollen.

HONEYSUCKLE (*Lonicera sempervirens* L.; Caprifoliaceae). It is an evergreen twining shrub which has several cultivated varieties. There are many wild species of honeysuckle distributed all over India. They bear, white, yellow, pink, purple or scarlet flowers in spring and the monsoon. Honeybees mostly collect pollen from it, but if the corolla tube is cut by wild bees or the corolla tube is short, honeybees collect nectar also.

POINSETTIA (*Euphorbia pulcherrima* Willd.; Euphorbiaceae; *panjpatia*). It is a cultivated shrub grown in gardens in the plains. The flowers are small and inconspicuous but have large red bracts or leaves clustered near the top. It blossoms during the winter months—November to January and supplies both pollen and nectar.

PRIDE OF INDIA (*Lagerstroemia indica* L.; Lythraceae; *harshingar*). This ornamental is grown as a bush or tree and thrives well over a wide range of climatic conditons. Varieties with pink, blue, purple and white flowers are available. It flowers from May to July and is eagerly visited by bees for pollen (Fig. 51).

PORANA VOLUBILIS Burm. (Convolvulaceae). It is a Malayan climbing shrub commonly grown in gardens in South India. It flowers in November and yields nectar.

POPPY (*Papaver somniferum*. L.); Papaveraceae, opium poppy, *post, khiskhas*. It is grown in gardens as an ornamental and is found as an escape of the previously cultivated crop, now prohibited, in different parts of India. Bees collect greenish pollen from it during spring.

PORTULACA (*Portulaca grandiflora* Hook.; Portulaceae). It is commonly known as the sun plant and is a good pot plant as well as bed plant. The colour range of its flowers varies from pure white to yellow, rose, scarlet, deep red and purple. It blossoms from May to August and supplies abundant pollen to the bees.

PURSLANE (*Portulaca oleracea* L. var. *sativa* DC). It is also commonly met with as a weed in waste places and vegetable gardens.

RANGOON CREEPER (*Quisqualis indica* L; Combretaceae). It is a rapid growing, evergreen and hardy perennial climber and bears flowers in bunches in May to September. Bees visit it for nectar in

May and June when the copious nectar secreted by it flows along the floral tubes.

Roses (*Rosa* spp.; *R. macrophylla* L.; *R. moschata* Mill.; Rosaceae; *gulab, gulabari, kuja*). Climbing varieties of roses are found growing wild in sub-mountain and hilly tracts of India. They usually blossom in spring (March to May) and are eagerly visited by bees for pollen. They help a great deal in brood rearing. Cultivated climbing and bush varieties which bear single flowers are also visited by bees who ignore the varieties with double big sized flowers with enormous corollas.

Sunflower (*Helianthus annuus* L.; Compositae; *suraj mukhi*). It is grown all over India as an ornamental and in a few localities as a fodder crop. It flowers from June to August and bees collect mainly pollen and some nectar from it. Dwarf and narrow leaved plants are better yielders as compared to tall and broad leaved varieties.

Zinnia (*Zinnia* spp.; Compositae). This ornamental is grown throughout India and the young plants from the nursery are transplanted during the rains. It blossoms from July to September and is often visited by bees for pollen. Certain varieties are altogether disregarded by bees.

The following are other minor sources of pollen and nectar: Gaillardia-*Gaillardia* sp. (Compositae), nasturtium-*Tropaeolum* sp. (Tropaeolaceae), marigold-*Calendula officinalis* L. (Compositae) varieties with open and single flowers.

The following are other minor sources of nectar only:—*Hydrangea hortensis* Siebold (Saxifragaceae); violet-*Viola odorata* L. (Violaceae).

The following are other minor sources of pollen only: Duranta-*Duranta plumieri* Jacq. (Verbenaceae); Coreopsis or calliopsis-*Coreopsis drummondi* Torr. and Gran. (Compositae); buttercup-*Ranunculus laetus* Wall. (Ranunculaceae).

The following common ornamental flowers are more or less useless for honeybees:

Acroclinium, antirrhinum, amaranthus, azaleas, bougainvillaea, candytuft, canna, celosia or cockscomb, cineraria, chrysanthemum, dianthus (carnation), dimorphotheca, jasmine, kiss-me-quick, kochia, lantana, linum, linaria, love-lies-bleeding, larkspur, nemesia, pansy, phlox, petunia, passiflora, sweet peas, touch-me-not, verbena and vinca.

Crops. Rice, wheat, barley, oats are rarely visited by bees though they may collect some pollen from them. Sugarcane does not flower in most places and even if it does, it would yield some pollen. Graminaceous millets like *bajra* (*Pennisetum typhoides* Stapf. and Hubbard), *ragi* (*Eleusine coracana* Gaertn.), *kodra* (*Paspalum scrobiculatum* L.), *chinna* (*Panicum miliaceum* L. & *P. miliare* Lam.), *swank* (*Echinochloa colona* Link. & *E. crusgalli* P. Beauv.) are grown all over India for grain and fodder and supply varying quantities of pollen.

BUCKWHEATS (*Fagopyrum esculentum* Moench, *F. cymosum* Meissen. & *F. tataricum* Gaertn; Polygonaceae). They are short-season, quick-growing crops sown after the rains at altitudes from 5,000 to 11,000 feet above sea level. They bloom in the autumn and yield both nectar and pollen. The plants yield these substances only in the forenoon and the honey is dark and strong-flavoured. The area under these crops in any locality in India is small and a pure honey crop is not possible to obtain as it is in some States of the U.S.A.

CHOLAM (*Sorghum vulgare* Pers.; Gramineae; *jowar*). This crop is widely grown all over India for grain and fodder. It flowers in summer and autumn and yields abundant quantities of pollen.

COTTON (*Gossypium* spp.; Malvaceae). Several species of cotton are grown all over India. They are sown at different times of the year in different areas and put forth blossoms over a period of four months or so in each locality. Most species are visited by bees for pollen. Some species, for instance, Combodia cotton in South India, yield nectar from the floral and extra-floral (involucral and leaf) nectaries and bees collect a surplus crop of honey from them. The colour of honey made from the nectar from Combodia cotton is reddish in December to January because of the meagre honeyflow and as the season advances the colour changes to a rich golden yellow. On the whole cotton honey is said to be excellent with very sweet taste, light aroma and fairly thick consistency.

CRUCIFEROUS OILSEEDS (*Brassica* spp.; Cruciferae; rape mustard, *toria*, *raya*, *sarson*, see also cruciferous vegetables). Large areas of cruciferous oilseeds are grown in different parts of India for their seed and also as fodder which are allowed to flower.

They blossom in winter and spring and are abundant sources of nectar and pollen. They yield a surplus honey crop from January to March. The honey is light yellow and granulates quickly, (See also Table 6).

ROCKET-*taramira*. (*Eruca sativa* Lam.) It is grown over a small area and is an erratic yielder of both pollen and nectar.

DECCAN HEMP (*Hibiscus cannabinus* L.; Malvaceae). This crop which is grown for fibre blossoms in hot weather. It yields both nectar and pollen, but is only a minor source.

SANNHEMP (*Crotalaria juncea* L.; Leguminosae). It flowers in autumn but is not known to be visited by bees.

GRAM (*Cicer arietinum* L.; Leguminosae). It is a dry region pulse crop grown throughout India. It flowers in February and bees visit it for pollen and nectar, but is not at all a dependable source. It is only in certain years that bee visits are noticed.

HEMP (*Cannabis sativa* L.; Urticaceae; *bhang*). It is a common weed which grows up in waste places and on the roadsides up to 7,000 feet above sea level. The cultivated varieties (for fibre and alkaloid) are sown during early rains and blossom in autumn. Bees gather pollen from it.

LUCERNE (*Medicago sativa* L.; Leguminosae; *alfalfa*). It has been introduced as a fodder crop in many parts of India particularly in areas where horses are bred. It has been noticed that bee visits to its flowers are rare in different parts of the Punjab but in U.P. and South India bees go to lucerne fields for nectar and pollen. It is the most important honey plant in irrigated, arid and semi-arid tracts of the U.S.A. *M. denticulata* Wild.; *maina* and *maini-Trigonella polycerata* L. are not visited by bees but they go to *maithi* fields (*T. foenumgraecum* L.) for nectar and pollen.

MAIZE (*Zea mays* L.; Gramineae). It is widely grown all over India for grain and fodder. It flowers in summer and autumn. Bees visit it eagerly for pollen.

MELLILOT (*Melilotus indica* All.; Leguminosae; *senji*). It is a fodder crop grown throughout India. It blooms from February to March, but does not attract bees.

Yellow sweet clover (*M. officinalis* L.) and white sweet clover (*M. alba* Desr.) have been tried on a small scale in Northern India and bees visit their blossoms eagerly.

NIGER (*Guizotia abyssinica* Cass.; Compositae; *ramtil*). It is an African plant cultivated as an oilseed in South India. It produces conspicuous yellow flowers in November and December and bees visit its fields for pollen and nectar.

PULSES (*Phaseolus* spp., *Cajanus cajan* L., *Vigna sinensis* Savi., *Cyanopsis tetragonoloba* Taub., *Dolichos* spp., *Lens culinaris* Medic., *Vicia faba* L.; Leguminosae). These pulses are grown all over India in fairly large areas, but bees visit them occasionally to collect pollen. These plants cannot be depended upon.

LIMA BEANS (*Phaseolus lunatus* L.). These are a major nectar secreting variety in California, U.S.A.

SAFFLOWER (*Carthamus tinctorius* L.; Compositae. *kasumbha*, Bastard saffron). It is cultivated to a limited extent throughout India for its flowers from which a dye is made and for its seeds which are pressed for oil. It blooms from January to February in the Punjab and in September in Madras. It is visited by bees for nectar and pollen.

POHLI (*Carthamus oxyacantha* Bieb). It is a very prevalent weed in wheat fields and is visited by bees for pollen and nectar but is rather a poor source.

SESAMUM (*Sesamum indicum* L., Pedaliaceae; *gingelly*, *til*). It is a crop commonly grown throughout India. It blossoms from July to September and bees obtain both pollen and nectar from it. It is a minor source.

SESBANIA (*Sesbania aegyptiaca* Pers., *jaintar*; *S. bispinosa* Fawcett and Rendle, *dhaincha*; *S. grandiflora* Pers; *agathi*; Leguminosae). The three crops are grown all over India and are reported to yield nectar to bees in South India. They are, at best, minor sources.

TOBACCO (*Nicotiana tabacum* L.; Solanaceae). It is extensively grown all over India and blossoms (whose production is discouraged) at different times of the year in different localities. Bees gather pollen and sometimes overflowing nectar from it.

Lovell records cases from the U.S.A. where in neglected fields the flowers hang down with nectar flowing from the nectaries. Bees collect it easily. The honey is said to have a dark brownish colour and no disagreeable results follow from its consumption.

Herbs. Several weeds in fields and plants growing in waste land are sources of surplus honey. Some of the important wild and cultivated herbs are listed overleaf:

ANEMONE (*Anemone vitifolia* Buch-Ham.; Ranunculaceae). A weed and an ornamental which flowers from June to September and yields pollen.

BALSAM (*Impatiens glanduligera* Royle; Balsaminaceae; *grahma*, touch-me-not). It is an erect succulent herb with branches and hollow stems and is common in moist places up to 4,500 feet above sea level. It blossoms from July to September and nectar is secreted in the narrow curved spur at the base of the flower. The bee's back is dusted white with pollen from the overhead stamens. It is a major source of nectar and often yields a surplus crop of honey.

Several other wild varieties namely *bicoruta*, *cristata*, *racemosa*, etc. belong to the Himalayan region and are useful honey plants. The ornamental variety *I. balsamina* L. is usually of double type and of no use to bees as a nectar source. Some pollen is collected.

BIDENS (*Bidens pilosa* L.; Compositae). It is an erect herb found as a weed up to a height of 6,000 feet above sea level. It blossoms from September to December in South India and yields both pollen and nectar. It is a minor source in India but one of its relatives spanish needle, *B. aristosa* (Mischx.) Britton is a major honey plant in the U.S.A.

CHICORY (*Cichorium intybus* L.; Compositae; endive, succory). It is a perennial herb with milky juice and is cultivated in certain parts of India. It is met with wild up to a height of 6,000 feet above sea level. In the Punjab, it is found as a weed in *berseem*—*Trifolium alexandrinum* L. It blooms from March to May and bees gather nectar from it. It is a minor source.

Chionachne koenigii Thw.; Gramineae. It is a herb common in South India up to 3,500 feet above sea level. It blooms in July and yields both pollen and nectar.

CLEOME (*Cleome viscosa* L.; Capparidaceae; *hulhul*; wild mustard). It is an erect annual herb which is a common weed in *kharif* crops, wastelands and rubbish heaps. Its yellow blossoms come forth from June to September and yield both pollen and nectar. It is a minor source. Ornamental cleomes are often visited by bees. In the U.S.A. several species are excellent honey plants.

DANDELION (*Taraxacum officinale* Weber; Compositae; *dudhli*). It is a perennial herb with milky juice and is widely met with in lawns, pastures and fields at heights up to 8,000 feet above sea level.

Fig. 51. Inflorescence of Pride of India

Fig. 52. A flowering shoot of citrus

Fig. 53. A branch of a barberry bush with inflorescence

Fig. 54. A *shaun (Plectranthus rugosus)* bush at the peak of flowering

It flowers from March to November though it does not flower abundantly in autumn. It supplies both nectar and pollen to the bees and is only occasionally eagerly visited.

EUPHORBIA (*Euphorbia royleana* Bross.; Euphorbiaceae; *danda thor*). It is an erect glabrous fleshy shrub of cactus like aspect containing milky juice. The involucres are yellow in compact sessile three flowered cymes arising from the sinus between the nodes. It is common in dry hills and is often planted as a hedge plant around fields to protect crops from cattle. It flowers from April to May and bees collect pollen from it. Occasionally it yields some nectar. It is a minor source.

Several other *Euphorbias*, namely *helioscopia*, *hypericifolia*, *thymifolia*, *hirta*, *prostrata*, *dracunculoides*, *antiquorum*, *heterophylla*, etc. are troublesome weeds found in fields, lawns and along water courses and are occasionally visited by bees for nectar and pollen.

The ornamental poinsettia-*E. pulcherrima* Willd. has been described earlier.

Lagascea mollis Cav.; Compositae. It is an immigrant from Central America and has established itself as a weed in South India. It blooms in November and yields nectar.

MINT (*Mentha sylvestris* L.; Labiatae; *kusma*, wild mint). It is a strongly scented erect herb commonly met with as a weed in wet places, along water channels and rice fields. A cultivated variety is grown in vegetable gardens. It secretes nectar which is eagerly collected by bees. In India it is reported as a minor source only, though in the U.S.A. several species of *Mentha* are major honey plants.

MUGWORT (*Artemesia vulgaris* L., *Artemesia parviflora* Roxb., *Artemesia maritima* L.; Compositae). These perennial herbs occur widely in the higher hills and blossom in autumn. They yield pollen. Several ornamental varieties are also grown.

NERINGI (*Tribulus terrestris* L.; Zygophyllaceae). This herbaceous weed is chiefly found in hot dry localities in South India and flowers in November and yields nectar to bees. It also yields a blue dye resembling indigo.

Pentapetes phoenicea L.; Sterculiaceae. It is a cultivated annual with showy scarlet flowers and often runs wild. It blooms in November and yields pollen.

PLANTAGO (*Plantago* spp.; Plantaginaceae; *isapgol*). Several species of *Plantago* are met with in the hilly tracts of India along roadsides, pastures and on wastelands. They flower from March to September. During certain days of spring and summer these plants are eagerly visited by the bees for pollen.

POLYGONUM (*Polygonum* spp.; Polygonaceae). Several species namely *amplexicaule*, *aviculare*, *capitatum*, *glabrum*, etc. are met with in different parts of India. They are slender erect herbs with tufted stem and bear white to pink blossoms crowded in one or two racemes. They flower from July to October and yield nectar and some pollen. They are erratic yielders and are considered minor honey plants in this country. The ornamental varieties are often useful.

THOROUGHWORT (*Eupatorium hetero-clinium* Griseb.; Compositae). It is an erect perennial herb associated with peaty swamps and marshes. It blossoms in July in South India and yields both nectar and pollen but is a minor source.

WHITE GOOSE FOOT (*Chenopodium album* L.; Chenopodiaceae; *bathu*). It is a common weed found throughout India and is also cultivated in the hilly tracts during the rainy season for its leaves and seed. It blooms from March to May and from August to September. Bees collect pollen from it. It is a minor source.

BAN-AJWAIN (*Chenopodium ambrosioides* L.) is met with as a weed and is visited for pollen by the bees.

WILD WHITE CLOVER (*Trifolium repens* L.; Leguminosae). It is a perennial herb commonly met with in grassy pastures, along water channels and in fields from 4,000 to 8,000 feet above sea level. If flowers from March to August and provides nectar and pollen. It is an erratic yielder and a surplus honey crop from this source has not so far been reported in this country.

EGYPTIAN CLOVER (berseem)—*T. alexandrinum* L., Persian clover (*T. resupinatum* L.) and red clover (*T. pratense* L.) have been introduced in this country, the first two as fodders and the last as leguminous cover crop. Bees visit the first two for nectar and pollen and if the plants are out late for fodder and the blossoms are allowed to stay, a surplus honey crop is often obtained. Red clover is only occasionally visited by bees.

YELLOW MEXICAN POPPY (*Argemone mexicana* L. Paperveraceae; *sial kanta*). It is an erect herb which excludes yellow juice on cutting.

It commonly grows on the sides of fields, along railway lines, irrigation channels and on wastelands. The flowers are bright yellow and are very conspicuous. It blossoms in December in Madras and yields pollen.

Bushes and Shrubs. Stony hillsides, wastelands and forest undergrowth abound with bushes and shrubs whose blossoms are eagerly visited by bees for both pollen and nectar. Because of the large areas covered by them, they are responsible for major honey-flows in different areas. Some important kinds are described below:

BANNAH (*Vitex negundo* L.; Verbenaceae). It is a large wild shrub, sometimes a small tree common in sub-Himalayan tracts rising up to 4,000 feet above sea level and is commonly grown as hedges and as an ornamental plant. It blooms in April or June and bees visit it occasionally for nectar.

BARBERRY (*Berberis lycium* Royle and *B. aristata* DC. Berberidaceae). It is a wild shrub which grows as forest undergrowth in the Himalayas (Fig. 53). Various species blossom from February to June according to the height of area and yield both pollen and nectar. A surplus crop (about 15 lb.) is sometimes obtained but it is an erratic yielder. Barberry honey is dark in colour and strong in flavour which reminds one of molasses.

CASTOR (*Ricinus communis* L.; Euphorbiaceae). It is an evergreen soft wooded shrub or small tree, naturalised in the sub-Himalayan tract and the plains. It is also sown as an annual crop. It yields pollen in various seasons. Both floral and extrafloral nectaries are functionless.

COFFEE (*Coffea* spp.; Rubiaceae). This deciduous shrub is cultivated in South India on a large scale and blooms in April. Bees help a great deal in its pollination and they obtain both pollen and nectar from it. It is only a minor source.

KARUNOCHI (*Justicia gendarussa* L.; Acanthaceae). It is an erect perennial undershrub with small red flowers and is very common on wastelands and by roadsides in South India. It flowers in March and is visited by bees for nectar.

Petrea volubilis L. Verbenaceae. It is a beautiful climbing shrub of Tropical America with violet flowers and purplish calyx. It is commonly grown in gardens. It flowers in March and yields nectar to the bees.

PLECTRANTHUS (*Plectranthus rugosus* Wall. and *P. coesta* Ham.; Labiatae; *shain*). It is one of the commonest shrubs met with on stony hillsides on a sharp gradient in temperate Himalayas and is gregarious in nature (Fig. 54). It flowers from August to October and is a major source of nectar for the autumn crop in higher hills. It also supplies pollen. The honeyflow from this source seems to be a gamble in rain as heavy rains before the flowering period for abundant growth and occasional rains during the honeyflow for keeping up the soil moisture and optimum humidity conditions for nectar secretion are essential. Cold nights and clear warm days are ideal for the same purpose. Bees collect from 15 to 20 lb. of honey per colony from this source.

It yields almost water-white honey which on granulating looks like buffalo's butter. It is mild in flavour.

Ruellia prostrata Poir. (Acanthaceae). It is a diffuse undershrub met with in dry areas on banks and in gardens. Its pale blue or purple flowers appear in February in South India and have nectar for bees.

TEA (*Camellia thea* L.; Theaceae). This evergreen shrub, indigenous to China has been introduced in Assam, West Bengal, South India and the Punjab. It flowers in winter and has pollen for bees. As under proper cultivation it is not allowed to blossom this plant is of little importance to beekeeping.

THORN APPLE (*Datura stramonium* L., *Datura metel* L., *Datura alba* L.; Solanaceae). Several species of wild and cultivated *datura* are met with in India and bloom from June to October. They yield pollen. They are a minor source.

WILD MARJORAM (*Origanum vulgare* L.; Labiatae; *jangli marua*). It is an erect aromatic perennial herb which grows wild in higher hills up to 7,000 feet above sea level. It blossoms in August to September and yields both nectar and pollen.

Forest and Avenue Trees. In tropical and sub-tropical areas, nectar sources are chiefly trees. They blossom for a short duration, their nectar secretion is less copious compared to herbaceous plants and are, in general, erratic yielders. However, some of the major honey crops are obtained from them. Some of the important sources are described below:

ACACIAS (*Acacia* spp.; Leguminosae; *babul, kikar*, catechu,

wattles). Several species of *Acacia* namely *arabica, catechu, caesia, concinna, farnesiana, leucophloea, modesta, torta,* etc. are met with in India. Large areas under individual species are to be found. Some exotic wattles, that is, *A. dealbata* and *A. decurrens,* have been introduced. Different species flower at different times of the year and have pollen for bees. Nectar is also, often, obtainable from the extrafloral nectaries. *Acacias* are not a dependable source.

ALANGI (*Alangium salviifolium* Wang.; Alangiaceae). It is a small deciduous tree found all over India up to the height of 6,000 feet above sea level. It blossoms in spring (March to May) and yields both nectar and pollen in Madras.

A. begoniifolium Baill. (*sirash*). It is not known to be visited by bees in the Punjab.

ARJAN (*Terminalia arjuna* Wight and Arn.; Combretaceae; *arjan*). It is a large avenue tree indigenous to Central India and cultivated as a shade tree throughout India. Its flowers are pale, yellowish white in axillary and terminal, usually paniculate spikes. It blooms in May to June and in certain localities, like Lyallpur in West Pakistan, is a major source of nectar and yields surplus honey of amber to dark amber colour with a characteristic pungent flavour.

Terminalia chebula Retz. (*Myrobalan-harar*) and *Terminalia bellerica* Roxb. (*bahera*) are widely distributed throughout India and yield some nectar in summer.

BAMBOO (*Bambusa bambos* Druce and *Dendrocalamus strictus* Nees; Gramineae; *bans*). Bamboos of various species are met with all over India. They bloom from November to April after long intervals or sometimes sporadically. Bees collect both nectar and pollen but bamboos are of little importance to beekeeping.

DOMBEYA sp. (Sterculiaceae). It is an introduced African tree which flowers in November in South India. It yields nectar.

DRUMSTICK (*Moringa oleifera* Lam.; Moringaceae; horseradish tree, *sohanjna*). It is a deciduous tree native to India and is commonly grown for its flowers and pods which make tasty dishes and pickles. It flowers in February and yields nectar. It is a minor source.

EUCLYPTUS (*Eucalyptus* spp.; Myrtaceae). These are evergreen trees which reach gigantic size and are indigenous to Australia. A few trees are commonly planted in all big stations. They bear

white bisexual flowers borne in simple or paniculate umbels. The various species blossom in winter and spring from November to April and are eagerly visited by bees in large numbers for nectar. In view of their being too few in this country, *Eucalypti* are of not much consequence but the Australian honeycrop is largely obtained from this source.

GERANIUM TREE (*Bauhinia variegata* L.; *B. purpuria* L. and *B. hookeri* F. Mull.; Leguminosae; *kachnar, kolar, khairwal, mandharai*). These trees are commonly cultivated in villages and along field *bunds*. They bloom early in winter and early in spring and yield nectar and pollen. As the buds are eaten as a vegetable, bees have little chance of taking proper advantage of the blossoms.

CAMEL'S FOOT CLIMBER (*Taur, B. vahli* Wight and Arn). Its broad leaves are used for serving food and wrapping parcels. It blossoms from April to June and bees visit it for nectar.

Gliricidia sepium Steud. (Leguminosae). It is an introduced small tree from Central America and is cultivated in South India. It blooms in March and yields nectar.

INDIAN ELM (*Holoptelea integrifolia* Planch.; Urticaceae). It is a large deciduous tree met with throughout India and is cultivated for roadside shade or as an ornamental. It is much lopped for fodder. It blooms in February and has plenty of pollen for bees.

INDIAN LABURNUM (*Cassia fistula* L.; *C. laevigata* Wall. and *C. angustifolia* vahl.; Leguminosae; *amaltas, bhainsiya, banar*). It is a medium-sized deciduous tree which is cultivated as an avenue tree and is found throughout India (frontispiece). It produces yellow flowers in drooping racemes and is an exceedingly showy tree when in bloom, being at this time all flowers and no leaves. It flowers in May to June and yields pollen. Bees can collect also nectar from the extra-floral nectaries located at the base of the leaf stock.

KADU-HIPPE (*Madhuca latifolia* Roxb.) McBride; Sapotaceae; *mohwa*). It is a deciduous tree grown throughout India in gardens for its flowers, the corollas of which are eaten raw or cooked. The seeds yield an oil which is used for making soap. It blossoms in February to March and has nectar for bees.

M. longifolia L. (Cocoanut palm) and *Bassia butyracea* Roxb. are also reported to be good sources of nectar.

MARGOSA (*Melia indica* Brandis; Meliaceae; *neem*). It is a large

glabrous evergreen tree. Its various parts reputedly possess disinfectant qualities. It is cultivated throughout India as an avenue and shade tree since it needs little care. Its dirty white flowers which come out from March to May, yield nectar. *Neem* is a very erratic yielder and there are conflicting views on its usefulness as a honey plant. A closely related tree, Persian lilac (*Melia azedarach* L.) has not been noticed to be visited by bees.

BARNA (*Crataeva religiosa* Forst.; Capparidaceae). It is a medium-sized deciduous tree which occurs throughout India and is also cultivated in gardens. It blooms in April to May and yields nectar.

MESQUITE (*Prosopis juliflora* D.C.; Leguminosae; *walaiti jand*). It is a small or medium-sized evergreen or semi-evergreen tree with long zig-zag straggling branches. It is indigenous to North and South America, but has been introduced all over India to clothe the dry and bare hill soils in localities deficient in rainfall. It has been found useful for checking erosion. The creamy white blossoms issue forth in March and bees collect nectar from them. It is a minor source in India but is an invaluable honey plant in the southern States of the U.S.A. and Hawaii.

MORETON BAY CHESTNUT (*Castanospermum australe* Cunn.; Leguminosae). It is an evergreen tall Australian tree, cultivated in South India. The flowers are yellow to orange and reddish in colour and blossom in March. It yields both nectar and pollen.

NONA (*Morinda tinctoria* Roxb.; Rubiaceae). It is a moderate-sized deciduous tree which blossoms in March in South India and yields nectar.

PALMYRA PALM (*Borassus flabellifer* L.; Palmae). It is a cultivated palm and also grows wild up to a height of 2,500 feet above sea level. It blossoms in March and yields pollen.

PUNA (*Ehretia acuminata* R. Br.; Boraginaceae). It is a medium-sized deciduous avenue tree which is heavily lopped for fodder. It produces white sessile flowers in large bunches throughout April. It has nectar for bees who virtually 'swarm over' the inflorescence. It is an important source of nectar and yields about 10 lb. of honey to a bee colony during its season. *Puna* honey is amber coloured with a characteristic flavour.

PUNGAM (*Pongamia pinnata* Merr.; Leguminosae). It is a moderate-sized evergreen tree commonly met with on coastal forests

and tidal river-banks in South India. It is also often grown in gardens and planted as an avenue tree. It blooms in March and yields nectar.

SANDAL (*Santalum album* L.; Santalaceae; *chandan*). It is a small evergreen usually semi-parasitic tree with brownish purple flowers. It is common in South India up to 3,000 feet above sea level where it blossoms in November to December and yields nectar.

SISSOO (*Dalbergia sissoo* Roxb.; Leguminosae; *shisham*). It is a large deciduous shade tree of great economic value for its timber which is suitable for furniture, doors and farm implements. It produces small yellowish blossoms bountiously in March to April, the honeyflow lasting for about two weeks. It is a major source of nectar and colonies gain about 10 to 20 lb. in weight during the period. *Shisham* honey is amber to dark amber in colour and is strong in flavour.

SILK COTTON TREE (*Salmalia malabarica* Schott et. Endl.; Bombacaceae). It is a tall deciduous tree found all over India. It blooms in February and March before the leaves appear. Honeybees visit the large flowers only occasionally though they are full of thin sweet fluid. Muttoo (1939) reports that it is a good nectar-yielding plant.

KAPOK (*Ceiba pentandra* Gaertn). It is the white cotton tree naturalised on the west coast of India and yields nectar in February to March.

SIRIS (*Albizzia lebbek* Benth; Leguminosae). It is a large deciduous tree found all over India and is frequently cultivated. Its whitish flowers are very fragrant and bloom in April or May. Bees collect nectar from it. An allied species *A. stipulata* Boivin is also visited by bees for nectar. These are erratic yielders and are, at best, minor sources.

SOAPNUT (*Sapindus detergens* Roxb. and *S. emarginatus Vahl.;* Sapindaceae; *retha*). It is a fairly large handsome deciduous tree cultivated as a roadside tree in Northern India. It is also planted for its brown fruit whose skin contains saponin (used as a substitute for soap). It produces numerous small greenish white flowers in large pyramidal bunches in the second or third week of May, the honeyflow lasting for a fortnight. It is a major source of nectar in

some localities and bee colonies gain 15 to 20 lb. in weight from this source. Soapnut honey is watery white to white in colour and has a mild flavour.

TAMARIND (*Tamarindus indica* L.; Leguminosae; *imli, tentul, puli*). It is a large evergreen shade tree cultivated in many parts of India where little frost is experienced. It puts forth pale-yellow red-striped blossoms from April to July and yields nectar. It is considered a good source of honey in South India.

MANILA (tamarind-*Pithecellobium dulce* Benth. and rain tree—*Samanea saman* Merr.) are introduced ornamental trees often grown in South Indian gardens. They yield nectar.

TOON (*Cedrela toona* Roxb.; Meliaceae). It is a large deciduous tree planted both in the plains and lower hills. It is highly valued for its red, evergreen easily worked, durable and white-ant-proof wood which is used for furniture, door panels, carving, etc. It produces small cream coloured flowers from March to April and honeyflow from it lasts for about 10 to 15 days. It yields nectar and reddish pollen. It is a major source of nectar and bee colonies gain 10 to 15 lb. in weight during its flow. It produces white to light amber honey with a pronounced flavour. *C. serrata* Royle-*darl* is met with at comparatively higher elevations and is also a good source of nectar.

WILLOW (*Salix* spp.; Salicaceae). Willows are cultivated in gardens and also grow wild throughout India. They bloom in February and March and are eagerly visited by bees for nectar which helps the bees in spring brood rearing.

WOOD APPLE (*Limonia acidissima* L.; Rutaceae). It is a small thorny tree common in dry forests of South India. It blooms in March and yields nectar.

COMMON FACTORS

It may be pointed out that the yield of pollen or nectar from the plants and trees in the above list varies from place to place and season to season. Abundant secretion of nectar by the flowers of a particular plant depends on various factors. Though it is possible to forecast the course of honeyflow from a certain plant from previous experience, there are no hard and fast rules for such an assessment. The beekeeper must make sure that his colonies have

a good population of young foraging bees with *high morale* at the start of a honeyflow. The above notes are at best pointers and each beekeeper shall have to prepare his own list for each locality separately.

It is often asked what should be the area of a crop or how many trees are needed to obtain a normal crop from a bee colony. No satisfactory answer which will hold good from locality to locality or year to year is possible, but it may be indicated that a few fruit trees, or some plots of ornamentals or a vegetable garden cannot sustain any large number of bee colonies, what to say of yielding any surplus honey. Besides, the beekeeper must not restrict his investigations to cultivated crops or trees but also take into account such wild herbs, bushes and weeds in the fields, along *bunds* and water courses as grow within a radius of about a mile or a mile and a half of the place where he wants to keep his bees. The best method to judge the suitability of a locality is to study bee colonies that may be found in their natural abodes and to actually keep three or four colonies for a few years at the place.

Any improvement in the bee-flora of a locality is a long and patient task and effective results may be achieved after persistent efforts over two or three decades. However, this is not an impossible task. White and yellow sweet clovers, which make up about 60 per cent of the honey crops at present in the U.S.A. were initially spread (by farsighted and enthusiastic beekeepers) through the dissemination of their seeds along roads, railway tracks, in waste places, etc. despite opposition by vested interests. Since the value of these clovers as fertilizers of soil, as conservers of soil on bare road banks and as hay was realised, the area of pasture land under them has immensely increased. There are many examples of such experience in various other countries. There are vast possibilities of planting useful avenue trees along new roads in rural forests and cultivating clovers and other plants to stop soil erosion under various soil conservation and river valley projects which have been undertaken under the Five Year Plans. Landscape engineers of new cities like Chandigarh could do a great service to beekeeping by planting desirable bee plants in the areas under their project. Some such plants which deserve consideration are:

1. **Trees.** Australian wattle (*Acacia dealbata* L.), basswood-

Tilia vulgaris Hayne., pride of India (*Lagerstroemia indica* L.), privet (*Ligustrum compactum* Hook.), *puna* (*Ehretia acuminata* R. Br.), Robinia (*Robinia pseudoacacia* L.), *siris-Albizzia lebbek* Benth., *sissoo-Dalbergia sissoo* Roxb., soapnut-*Sapindus detergens* Roxb., *toon*, *Cedrela toona* Roxb., and darl C. *serrata* Royle.

2. **Bushes etc.** Berries (*Rubus* spp., coral creeper-*Antigonon leptopus* Hook & Arn., Plectranthus-*Plectranthus rugosus* Wall., wild marjoram-*Origanum vulgare* L.

3. **Herbs.** White and yellow sweet clovers and white, Egyptian and Persian clovers.

Too enthusiastic beekeepers are, however, warned that no plant has so far been discovered which can be cultivated merely to provide forage to bees. The plants to be introduced must have other economic value in addition to being good honey plants. The example of soapnut may be cited. It is a handsome deciduous, shade tree which makes a good roadside ornamental. The nuts from a single tree may fetch an annual income of Rs. 5 to 15. The fleshy skin of the nuts contains saponin which is used as a substitute for soap for washing woollen clothes. Its wood is good as fuel and also as building timber. Again, *Plectranthus* is a shrub which is ideal for covering stony hillsides. Its dissemination on the Shankaracharya Hill in Srinagar has provided a nice cover for the bare hill in addition to providing a useful honey plant which yields nectar and pollen in autumn. Among the cultivated herbs one may mention the fast growing short-season buckwheat for altitudes about 4,000 to 5,000 feet above sea level.

CHAPTER 8

SEASONAL MANAGEMENT

An owner of wall and log hives usually does not bestow much care on his bees but takes away honey when it is there to be gathered. The modern beekeeper, however, must handle his bees in such a manner that the colonies are well prepared for the coming honeyflow. For instance, to make a good job of beekeeping he must see that his colonies are humming with young bees of foraging age and the honey-gathering instinct is dominant in them. Since the time of major honeyflow varies from locality to locality, the management practices naturally fluctuate. However, the principles underlying them are common and are discussed below. It is emphasized that beekeepers will have to adjust the directions given in this Chapter to their peculiar conditions and work out their problems in their own way.

SPRING MANAGEMENT

In the higher hills where there is a lack of honeyflow during severe winters, honeybees keep to their hives and emerge considerably weakened at the beginning of spring. If suitable provision had not been made for honey stores both for the winter and spring requirements late in autumn, the colonies may be examined as early as possible on a bright, warm and calm day to assess the condition of the colony, working of the queen, quantity of capped and uncapped brood, honey and pollen stores and to clean the colony of the *debris* accumulated during the winter. If spring flowers have blossomed, fresh nectar may also be noticed. This is the time when the colony 'goes all-out' to rear brood and invests all its resources in increasing its strength. If reserves are small copious feeding of sugar syrup (1:1) may be done to build them up to 15 lb. and more drawn combs be added next to the brood frames. If the queen is working unsatisfactorily, that is, she is laying sparingly and/or laying drone eggs, she must be replaced early with a young vigorous successor. It is a good practice to clip one of

Fig. 55. A flowering branch of soapnut tree

Fig. 56. Inflorescence of a *toon* (*Cedrela toona*) branch

the wings of the queen at this time. How this should be done has been explained in a later Chapter.

It may be pointed out that very weak colonies desert their hives if disturbed unnecessarily and are easily robbed out if they are fed sugar syrup without great care. It is a wise practice to unite them with others and follow the golden rule: "Always help first those that need the least help, leaving the weakest to be helped last". Colonies which are just below average strength may be helped by giving them each a frame or two of capped brood from strong colonies. Another good practice is to equalise the strength of the colonies to avoid disparity so that all require the beekeeper's attention at about the same time and respond equally to one kind of treatment. Beekeepers, however, are warned against over-expanding the brood nest and dividing it into two or more parts by insertion of frames with comb-foundation, because there are chances of the outlying brood being left unattended by the worker bees. Consequently, the neglected brood gets "chilled" because of the treacherous weather that is usually experienced early in spring. Each colony should be examined once a week or in ten days during the spring to judge its general progress, the quantity of work done by the queen, to give more frames or replenish reserves, if required. Shortage of frames or stores at this time of the year cripples the colony for the whole season and it is ill-prepared for a good honey-flow that may occur later on.

Similar management practices in the spring are needed in the lower hills and sub-mountaneous tracts, but in the plains the precautions against the expansion of brood nest, etc. can be relaxed considerably.

Swarm Prevention. Swarming is a bee's way of satisfying its natural urge for the propagation of the species. By this method the number of bee colonies is increased. The strength of this urge varies from species to species and from colony to colony. For example, *Apis indica* bees swarm heavily. The swarming tendency may be accentuated by several natural as well as artificial conditions. Among the former are the onrush of a sudden honeyflow, the sudden failure of the queen to lay eggs, and the unbalanced number of workers of different ages. Some of the artificial conditions are heat, lack of ventilation, lack of space for egg-laying and for honey

storage, artificial barriers of poor, drone and honey combs in the worker brood area, etc. Both kinds of conditions produce 'congestion' in the hive and this results in subordination of the 'honey-gathering' instinct. A large number of worker bees whose rightful place is in the fields, stay in the hive and cause more 'congestion'. Consequently, queen cells are raised and from one to seven swarms may issue forth in due course.

'Congestion' is a state, sign or condition which leads to swarming but cannot be called the motive or cause of it. Several theories have been put forth to explain swarming on bases other than the propagation of species. The 'brood-food theory of Gerstung' and 'presence of an abundance of wax-secreting bees' theory of Snelgrove' may be mentioned, but these and other theories do not explain all the phenomena of bee-life. The practical beekeeper, however, must take it as a normal annual occurrence, take steps to reduce swarming and its consequences and keep the honey-gathering instinct in his bees strong before he can expect surplus honey from them.

Since the strain and quality of a queen determine the trend of swarming in a colony, it is proper to urge that a sustained effort must be made to replace queens whose colonies swarm too much with those of less swarming tendency. Moreover, old queens should be replaced by young and vigorous successors. Whereas the former practice is a continuous process, and may be undertaken as suitable surplus queens become available, the latter may be adopted as a routine annual measure. In certain localities, most colonies change their queens by natural supersedure during the autumn and seldom swarm during the following spring. The presence of an old queen is an incentive to swarming and any method short of her replacement only postpones it and keeps the "swarming instinct" dominant. How new queens can be raised and how natural supersedure takes place have been described in detail in a separate Chapter.

The following are some more practices for checking swarming:

1. The colonies should be kept in shade and enough ventilation should be provided by taking out the entrance strip, raising the brood chamber about 1/8th of an inch above the bottom board and by shoving forward the super by an inch or so. During the last operation, there is a need for great care because on the sudden

stoppage of honeyflow, robbing breaks out and bee colonies suffer heavily.

2. The natural arrangement of the brood nest should not be disturbed. Only poor, irregular and drone combs should be removed and placed outside the brood nest or in the super so that they may not act as barriers. Similarly, frames whose major portion is filled with honey or pollen should be moved out of the brood nest or to the super. Maldistribution of frames produces 'congestion' in the beehive and stimulates swarming. Enough well-drawn worker brood combs should be provided in the brood chamber to keep the egg-laying aspirations of the queen satisfied. Further, judicious provision of supers according to the needs of the colonies and character of the honeyflow should be made because otherwise the colony will be short of space for honey storage.

3. When colonies have proportionately a larger worker brood area (six to seven Langstroth frames over 1,000 square inches in *Apis indica*-hill variety) and there is a danger of upsetting the normal ratio of age-groups, action should be taken to rid them of the excess brood which may be given to needy colonies as explained earlier in this Chapter.

4. Uncapped queen cells and capped drone brood may be cut out and melted in a solar wax extractor. It is a palliative only and postpones swarming by a week or two. If resorted to frequently and even when capped queen cells are found, the bees swarm without providing for a queen for the parent colony (that is without building queen cells). When the latter becomes queenless laying workers appear in due course. This procedure wastes much valuable time of the bees and the colony becomes ill-fitted to make the best of the honeyflow.

5. If the bees persist in building queen cells, the best procedure is (a) to divide the colony artificially into two; (b) to have a new queen mated; (c) to kill the old queen; and (d) to unite the two. How to divide and unite colonies is described in the next Chapter. In such cases the swarming urge is satisfied, the colony is requeened and no valuable time of the bees is lost. Such an operation also saves one climbing the trees, catching the swarms and sometimes total loss of bees. Various methods of dividing the colonies by removing the capped brood frames with queen cells and placing them in a

hive body either at right angles to the parent hive or on top of its supers with an entrance in the opposite direction (Demaree, Fig. 57, and Snelgrove plans) are recommended in the West but such arrangements have not so far been successfully practised in India with the local bees.

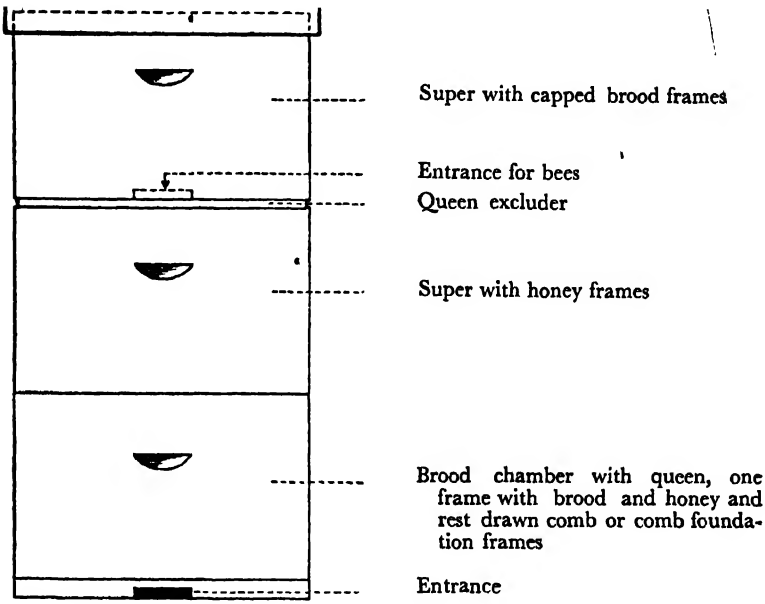


Fig. 57. Demaree plan of swarm control—Congestion in the brood chamber is relieved by shifting the capped brood frames to the super placed above a queen excluder and provided with an additional entrance

Handling Swarms. If, however, it is not possible to check swarming or to forestall it by artificial division, a wire entrance guard may be placed at the entrance of the hive to retain the queen and to make the bees return home. Immediate steps must be taken to divide the colony artificially. If the queen's wings have been clipped, the use of wire entrance 'guard' is mandatory. For without it the queen in her efforts to fly may fall off the bottom board to the ground and may get lost in the grass or may be picked up by black ants, etc.

Swarming generally occurs in the forenoon between 10 A.M. and 11-45 A.M., but occasionally it is noticed at other hours of the day. The bees come out in a rush and encircle the hive. When a fairly large number of bees has come out and the queen has also joined, the swarm settles on a branch of a nearby tree and forms a cluster on it. How to make them settle early has been explained in an earlier Chapter.

With a view to avoiding after-swarms as described earlier and maintaining the strength of the colony, it is better that the primary swarm should be hived at the site of the parent colony and the latter removed to a new site. In this way all the field force will return to the old home and strengthen the swarm which after having satisfied its swarming instinct will settle down to the work of honey-gathering. In the parent colony at the new site, a new virgin queen that emerges will cut the other queen cells, get mated and head the colony. After-swarms should be an unheard of occurrence in a modern apiary.

To make it settle down properly the swarm should be given one frame each of capped brood, honey and pollen. Sugar syrup (1: 1) should also be fed liberally. The entrance hole of the parent colony at the new site should be narrowed to check robbing and there should be landmarks around it so that the queen does not make a mistake in recognising it on return from her nuptial flight.

Swarming time used to be an exciting occurrence in the old type of beekeeping and the beekeepers looked forward to this natural process of increasing the number of bee colonies. But the energies of colonies were frittered away in breeding and surplus honey could be obtained only after years when there were prolonged honeyflows. With modern management methods, the excitement and consequent trouble of spraying water on to the swarms, seeing them cluster, catching and hiving them or chasing them all over the fields and fences have become unnecessary. Now the beekeeper very much prefers to forestall the bees and uses artificial methods of dividing colonies or separating the brood.

In nutshell, successful control of swarming can be attained by keeping a comparatively less swarming strain of bees, keeping young queens in the colonies, removing congestion by providing enough well-drawn combs for brood rearing and honey storage and

keeping the surplus bees from loafing in the brood chamber and making them work in the super.

During Honeyflow. Generally, the swarming season is followed by a good honeyflow*. Proper management of the bees is essential during these days if the beekeeper is to reap the reward for a year's effort. It is true that any amount of diligence during the honeyflow cannot make amends for the poor management in the preceding months but any oversight in these crucial days is certain to sweep a year's work of the bees and the beekeeper. Hence it is imperative that the beekeeper should arm himself with the correct information of the honeyflow trends and the state of the colony and handle his bees accordingly to make them store the maximum amount of honey. Without this the colonies would strengthen themselves on the honeyflow and would not yield the expected quantity of honey.

The principal function of the beekeeper during this period is to keep the 'colony morale' high. In other words, he should ensure that the honey-gathering instinct is dominant and the swarming instinct in check. As already explained, congestion in the hive must be avoided and the surplus 'house-bees' drawn to supers. A colony is particularly liable to have this trouble during the honeyflow because of the quick arrival of honey and the beekeeper should do his level best to remain ahead of the bees in providing space for storage. It is necessary to point out here that a great deal of space is required for the evaporation of honey than for its final storage and drawn combs, therefore, should be provided liberally. A second super should be added between the first super and the brood chamber and not above the first super. Additional supers may similarly be added just above the brood chamber and below the other supers. Colonies should be examined once a week and frames full of honey should be removed to the sides of the brood chamber or the super**. The frames which are filled, three-fourths with honey or pollen and one-fourth with capped brood should also be taken out of the brood nest. In contrast to *Apis*

*It is indicated by the whitening of the honey-cells, appearance of large quantities of burr and brace combs and increase in the weight of the colony.

**The writer commends the use of the same size of frame in the brood chamber and the super and deprecates the use of half-depth frames in the super. The handling of bees becomes much simpler, if frames in the apiary are standardised to only one size.

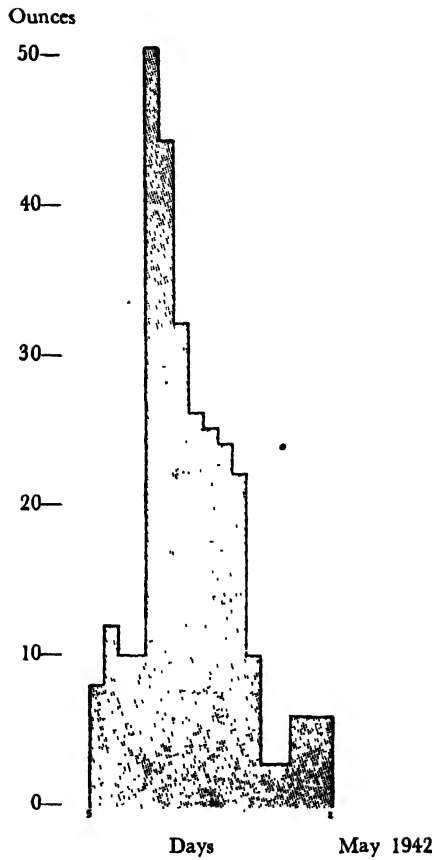


Fig. 58. Daily gain in ounces in the weight of an Indian bee colony during the soapnut honeyflow season at Nagrota (Kangra) from 5th to 21st May, 1942—Total gain 18 lb. 9 oz.

mellifera bees, the *Apis indica* bees draw comb-foundation best in the brood chamber. The frames with comb-foundation should be placed next to the brood nest but not in it where they will act as barriers and again lead to congestion. Often the beekeeper is short of drawn combs and it is not good for the colony to have more

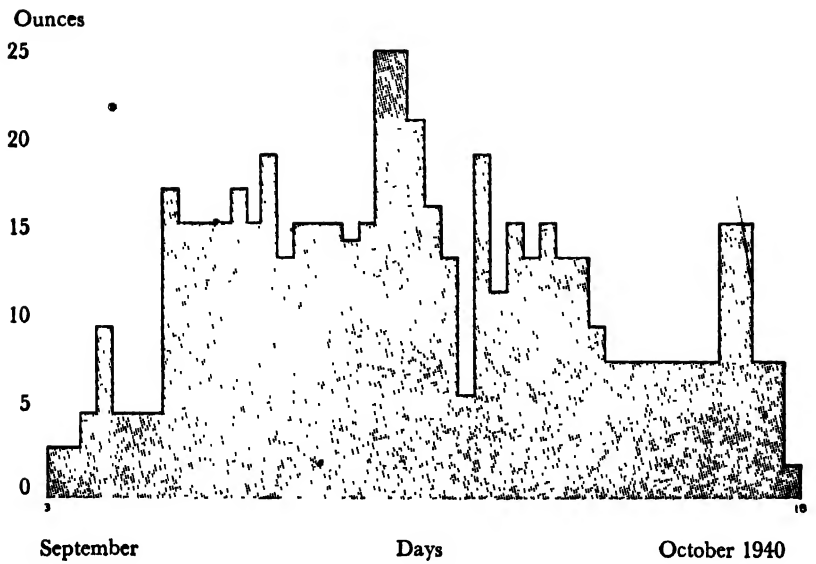


Fig. 59. Daily gain in ounces in the weight of an Indian bee colony during the *Plectranthus* honeyflow season at Katrain (Kulu Valley) from 3rd September to 18th October, 1940—Total gain 36 lb. 6 oz.

supers. In such cases completely capped or two-thirds capped honey frames may be taken out and replaced after emptying them. Such extraction, apparently, gives an incentive to the colonies and helps to activate the bees to store more honey. The extraction of thin, uncapped honey should, however, be avoided.

On warm days, bees are noticed to gather in large clusters at the entrance particularly at night. This is a sign of congestion caused by poor ventilation. If this is allowed to continue for some time, the honey-gathering instinct gets subordinated to the swarming instinct. The situation should be remedied promptly by improving ventilation* by removing the entrance strip or shoving the supers backward.

*In localities where nights are very cool (in case of autumn honeyflows) unlimited expansion of the hive is not advisable as it involves consumption of large quantities of honey by the bees for keeping the brood nest warm during the night. In such localities, partial extraction of honey during the course of the honeyflow with a view to avoiding over-expansion of the hive is advisable.

Fig. 60. Two colonies of bees with supers during the honeyflow season

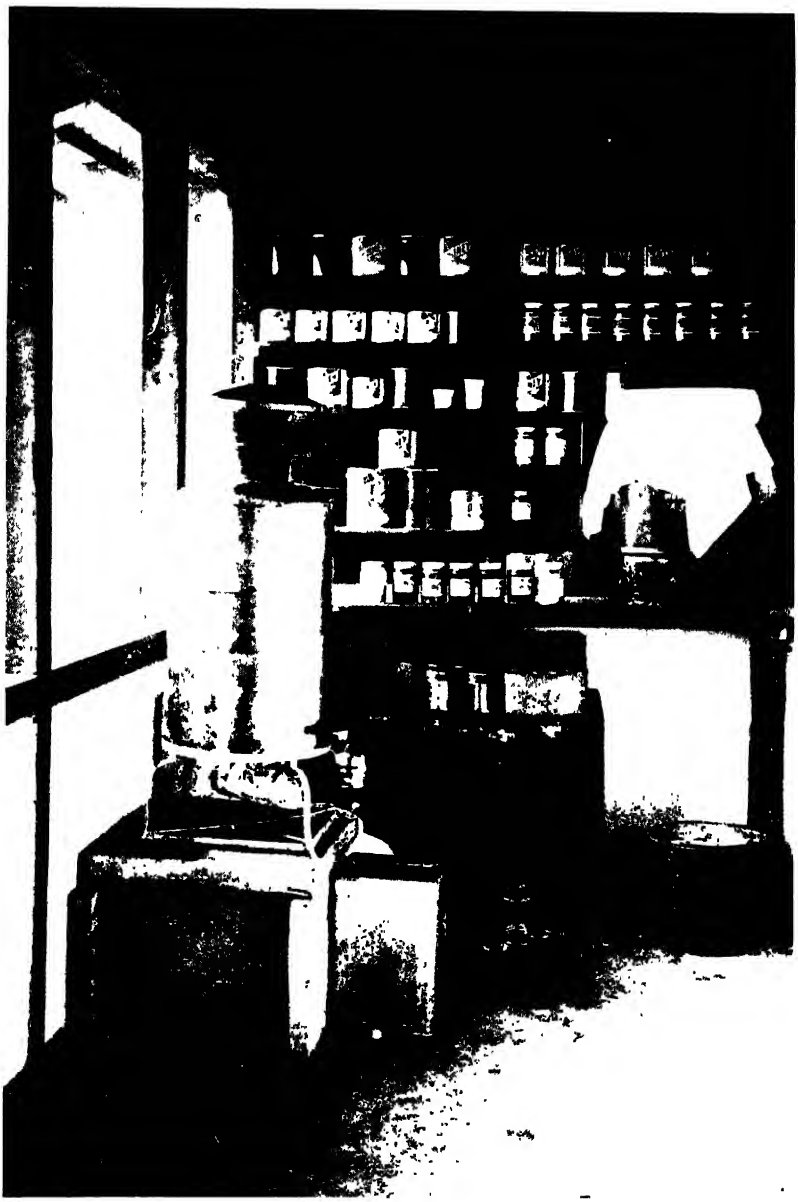


Fig. 61. Straining and bottling of honey

Honey Extraction. When the honeyflow begins to slow down (see Figs. 58 & 59 representative graphs for the course of the honeyflow from soapnut at Nagrota and from *Plectranthus* at Katrain in the Punjab), the frames containing honey should be removed. It is necessary to start extraction when bees are still bringing in nectar otherwise the robbing of weak colonies by strong ones may begin and there may be a general furore in the apiary. The consequences of this lawlessness in the bee world have been explained in the next Chapter. To remove honey combs, a colony is heavily smoked, the desired combs taken out and shaken and the bees brushed off with a wet brush or a bunch of green grass in front of the hive. These combs are placed in bee-tight hive bodies, removed to the extraction room and stacked one above the other. The honey frames which are less than 50 per cent full should not be removed. The frames containing capped or uncapped brood should on no account be taken out while removing frames of honey from the bee colony. It should be borne in mind that the modern beekeeper does not totally rob the colony of its honey stocks but takes away the surplus only. At least 15 lb. of honey should be left with the bees.

For the extraction of honey a room with wire-gauzed bee-tight doors is necessary. It is better if it has double doors. However, if such a room is not available, extraction can be done in the open at night. Cement flooring is preferable, otherwise the place should be treated with cowdung plaster. A lawn is unsuitable as honey drops which fall on the grass are difficult to remove. Several one-way bee escapes (Fig. 44) should be fixed in the extraction room to provide outlets for any stray bees that may have come in along with the honey frames. It is a good practice to have dry cowdung cakes smouldering at the doors of the extraction room to keep away robber bees. To uncap the frames either a steam-heated uncapping knife or a pair of plain uncapping knives with provision for heating them in boiling water should be arranged. A tray with an expanded metal screen is also required. If too hot knives are used a lot of wax from the cells would melt into the honey and solidify after some time into an undesirable layer over it. The uncapped frames should be placed in hive bodies with 'drip trays' underneath them to await their transfer to the extractor. Beginning slowly

the extractor should be worked at about 150 revolutions a minute for about one and a half to two minutes. Then the sides of the frames should be reversed and the extractor again worked for the same duration. The frames should be stacked in empty hive bodies when they are awaiting their return to the bees. The extractor should be emptied into a cistern when its honey chamber is two-thirds full. It is advisable to make arrangements for straining and packing honey into tins promptly to obviate a need for subsequent heating of the product (Fig. 61). Freshly extracted honey is warm and hence easy to strain. The partially dried cappings on the metal screen of the uncapping tray should be handled in the same way as crude honey.

After the job has been done the place should be swabbed with warm water and the appliances cleaned. The hive bodies must be thoroughly washed to remove the last traces of honey or its smell from them so that next morning the bees may not even have the inkling of what happened on the previous night. The empty (wet) combs should be returned to the bees for cleaning and the hive entrances shortened so much that only two bees can pass at a time. Every effort should be made to avoid robbing.

The colonies should be examined after about a week and the surplus empty combs taken away and stored under moth-proof conditions. Only enough combs should be left with the bees which they can easily cover. The spare hive bodies should be removed. The bottom boards should be cleared of *debris* and wax particles and any chinks and crevices plugged with cowdung-clay paste or 'plasticine'. If any colony has been stripped too much, the deficiency should be made up to an estimated 15 lb. of honey*.

SUMMER ROUTINE

In most localities the spring honeyflow is followed by a summer dearth period. If the colonies have been heavily stripped of their honey, they become broodless. There is a sudden decrease of workers and the cluster appears small. Such a thinning of workers' ranks is due to the death of old and decrepit bees who have put in strenuous work in gathering honey. Besides, the bee enemies increase and

*The quantity of honey stores which should always be available with a colony of *Apis indica* plains variety bees may perhaps be about 5 instead of 15 lb.

step up their nefarious activities. Bees are also known to gnaw down old and outlying combs. This is a rather testing period for the colony and may well be compared to the difficult winter season in the West. Besides protecting their hive against the enemies and robber bees, the bees have to keep their hive cool and properly ventilated.

In a 'left-alone' colony, the bees mostly stay indoors, do little work, remain listless and wait for the developing brood to emerge. The queen stops laying fresh eggs and even if she persists in depositing eggs, they are neglected by the bees and allowed to shrivel. When almost all the brood has emerged and not enough honey is left the colony 'swarms out' or absconds. Whereas swarming is the division of a colony into two with a view to increasing the number of colonies, absconding is desertion of the hive because of its unsuitability as an abode under the peculiar set of circumstances. Only empty combs without any brood or honey and sometimes riddled by tunnels of wax-moth caterpillars are left. The deserting bees behave almost in a similar fashion as swarming bees, except that the circling bees rise very high and it is rather difficult to make them settle down on limbs of small trees, etc.

The best thing to do during this period is to avoid broodlessness in the colonies and stimulate them to rear brood with a view to (*i*) making up the losses of dying bees and (*ii*) avoiding absconding. It has been noticed that strong colonies continue to rear brood, are not much troubled by bee enemies like wax-moth caterpillars, wasps, black ants, etc., do not gnaw combs, keep the robbers at bay and in addition are able to maintain their reserves by taking advantage of small honeyflows from minor sources. Hence colonies should be maintained in a strong condition by having them headed by young vigorous queens, not allowing their stores to fall below seven or eight lb.*, placing them in a cool, shady and protected place, keeping their enemies in check and avoiding conditions which lead to robbing. Other methods of treating weak colonies should be tried in the manner described earlier.

*It may be pointed out here that whereas in spring the bees invest their last drop of honey in rearing their young and practically live 'from the flower to the mouth', they heavily curtail their brood rearing activities during dearth periods in summer or autumn.

Causes of Absconding. The sudden decamping of colonies of bees dampens the enthusiasm of a beginner who often becomes 'a beekeeper without bees'. It may be stated that absconding is not spontaneous but the result of several causes which have been allowed to operate for too long. It is, therefore, a rare event in a modern and well-kept apiary. Shortage of reserves is one of the main reasons which induces the bees to make preparations for absconding. Starvation, at a time when the bees have to work to maintain their hives cool and well-ventilated and to keep the enemies and robbers at bay, makes the colonies very weak. Other causes are robbing, severe attack of enemies, too much handling of the bees and exposure and poor ventilation of the hive. These conditions also weaken the colonies and eventually they are compelled to give up housekeeping in their permanent abodes and abscond at this time of the year. Small truant swarms, it is known, seek admission to other colonies and submit to the slaughter that usually accompanies such events. However, individual bees sacrifice themselves for the common good. They add to the working force of their adopted colonies, increasing the latter's power to face the dearth period or the difficulties that follow it.

To check absconding the directions outlined in the preceding Chapters for keeping colonies strong should be followed. If, however, broodlessness persists, a wire entrance guard should be placed at the entrance of the hive to prevent the queen from joining the absconders. Without her they are sure to return home. It is helpful to clip the wings of the queen (Fig. 67) but this requires the services of an intelligent and vigilant attendant constantly. When no such attendant is available, this practice should not be adopted, as explained earlier, a clipped queen if not guarded by a wire entrance guard gets lost in the grass or is picked up by black ants or other vermins.

A colony which has been caught after absconding should be hived in the same manner as a swarm. The hive should be changed if the old one is smelling or is not bee-tight and placed in a cool, shady and ventilated place.

The hot summer months may extend from two (May and June) to six (May to October) in different localities. Bee management in the localities with a longer summer is difficult indeed but

can be successfully undertaken if the procedure outlined above is followed.

MONSOON PROBLEMS

The hot summer months are usually followed by the monsoon which brings difficulties of a different nature. In some localities bees are unable to stir out for long intervals. Large numbers of field workers are lost in sudden storms or downpours reducing the strength of the colonies. High humidity in the hive, coupled with comparatively high temperature, creates an unfavourable environment for bees. They become lethargic and listless and often suffer from dysentery. Pollen in the cells often becomes mouldy and thin honey in uncapped cells suffers fermentation. Bee enemies, on the other hand, grow in numbers and further weaken the colonies. The tendency to rob is accentuated.

Good management requires the intensification of the measures usually employed in summer as explained in the foregoing pages. Specially, thick groves of trees where the air stagnates and it is often unbearably hot and close, should be avoided. During the rains candy or dry sugar should be given to the bees if artificial feeding becomes necessary. The use of pollen substitutes like fat-free soyabean flour has often been found advantageous.

It is often noticed during the monsoons that a few weak colonies become queenless and laying workers appear. This apparently is due to the activities of robber bees. In most cases it is difficult to make such colonies accept new queens and it is advisable to unite them with others with proper precautions. Regular weekly examinations and constant vigilance to check robbing should end the possibility of laying worker colonies appearing in a modern apiary.

AUTUMN NEEDS

In the higher hills, autumn is marked by a second major honeyflow of the year and, therefore, the beekeeper should take anti-swarming precautions and otherwise handle his bees as he should do during a honeyflow. It cannot be over-emphasized that hives must not be expanded too much and must be kept warm. During this period many colonies make preparations to supersede old queens by raising a couple of queen cells. It is often found that both mother

and daughter are laying eggs on adjacent frames but eventually the old queen disappears. In the event of a sudden onrush of the honeyflow, the colonies which are in the midst of a supersedure, put forth swarms and thus divide their forces at a time when they are needed eminently. As said earlier, this can be avoided by dividing the colony or, if the swarm has issued, by hiving it on the old stand and removing the parent colony to a new site. Queens produced under the supersedure impulse are known to be good performers and as many colonies as possible should be 'requeened' during this period.

In autumn extracting and processing should be done in a warm room (80°—90°F) to avoid heating honey separately, which is a job too delicate for a beginner.

In the lower hills and sub-mountain tracts as well as the plains, the autumn is more or less a dearth period. If the summer is long or monsoonlike conditions persist broodlessness and the resultant absconding may occur.

The bees should be managed according to the summer and monsoon routines.

PREPARING FOR WINTER

Honeybees live in a thermal environment of their own and air-condition their nest at temperatures between 90° to 95° F. This is done at the cost of honey used for the effort of fanning in summer and for muscular movements to produce heat in winter. Insulation of their abode helps to reduce consumption of honey and save energy of the bees. The single-walled movable frame hive was devised for cheapness and convenience by commercial beekeepers, but is a poor home for bees in winter. Insulation is, therefore, called for in localities which have long spells of cold or where there is a wide difference between day and night temperatures.

For purposes of insulation the climatic zones in the different beekeeping tracts in the country may be grouped in four categories: (*a*) Equitable temperature throughout the year and the minimum temperature not falling below 50° F at any time of the year. (*b*) Three cold months, namely, December, January and February with the days generally bright and warm and the nights cold with frosty

mornings as in the Northern India plains. The fluctuations between the maximum and minimum temperatures during a period of 24 hours may be 40° to 70°F in the open and honeyflow from *Brassica* spp. may occur. (*c*) Four cold months from November to February with the cold being more intense and a larger number of frosty days (lower hilly tracts). Minor honeyflows from *Brassica*, *Prunus* and *Litsea* may occur. (*d*) Five cold months from November to March with severe cold and several snowfalls from mid-December to mid-February and cold winds from the North (higher hilly tracts above, 4,000 feet above sea level). No honeyflow occurs during the period.

It is clear that different management practices are needed in different regions. Whereas no insulation will be necessary in region (*a*), light insulation (1½" to 2") will be required in region (*b*). In region (*c*) the thickness of insulation should be increased from 1½" to 3" and in region (*d*) 2½" to 4" on all the six sides of the hive. This job is done usually at the end of the autumn and after the colonies have been properly prepared for the winter season. Only strong colonies with a large number of young bees and abundant honey (a minimum of 15-20 lb. in *Apis indica* hill variety colonies) and pollen reserves should be overwintered. Weak colonies will not be able to pull through the winter and should be united with others*.

Packing a Hive. Finely chopped dry grass, wood shavings, saw dust, dry leaves, chopped rice straw or wheat straw etc. are handy packing materials. To keep the packing materials in place an outer wooden case is built round a hive (double-walled hives —Fig. 26) or a group of hives or weather-proof "sisal kraft" paper available from hardware merchants is used. Packing should be done on all the six sides and the wrapping fastened well to leave numerous minute dead air spaces. Care should be taken to keep packing materials dry because moisture makes them poor insulators.

If the hives are located in a protected place like a verandah, the packing material can be kept in position around the hive with old pieces of gunny bags or some similarly improvised material.

*When it is desired to overwinter young mated queens in nuclei, three or four nuclei may be put in one bee hive with dummy boards between them and entrances in different directions. Heavy packing should be given in this case.

In the higher hills colonies can be placed in haystacks with suitable exit tunnels for the bees.

Winter Ways. If strong colonies with young bees and sufficient amount of honey and pollen have been suitably packed, no attention need be bestowed on them during the winter beyond ensuring that there are no leaks in the covers. The colonies may be opened during the spring. In the plains [region (*b*) above], the hives should be so packed that they can be opened from top and condition of the colony judged. This arrangement is necessary because the honeyflow from *Brassica* spp. stimulates the queen to lay eggs and the brood nest gets expanded to six or seven Langstroth frames. Surplus honey may also be stored. At Lyallpur in West Pakistan swarming is common even in January though minimum temperatures remain in the thirties. It is imperative to pack colonies in such regions but it should be done in such a way that they can be easily examined and expanded when necessary. Use of thick cotton quilts or pieces of old blankets over the inner covers is beneficial.

CHAPTER 9

MISCELLANEOUS MANIPULATIONS

THE beekeeper has many daily and seasonal problems which, if left unsolved, would militate against his ultimate objective to obtain from his bees as much surplus honey as possible. They have been mentioned in passing in the foregoing Chapters but it is necessary that the methods to tackle these problems should be described in detail.

Having More Bees. The old-time beekeeper relied on natural swarming for increasing his bee colonies and he had a difficult time when the season to capture and hive the swarms came.

The modern beekeeper is fortunate in having equipment such as movable frame hive and the like and his success is not so unpredictable as before. Now he does not depend on swarming for more colonies. He can check the bees he already has from swarming and can increase the number of his colonies by dividing. The swarming period is the best for dividing operations though, if surplus honey is not aimed at, they can be undertaken during a honeyflow period also. Three methods for increasing the number of colonies in an apiary are given below:

(*a*) TWO FOR ONE: A new hive with six drawn-comb and comb-foundation frames should be placed at the site of the colony to be divided. A frame full of honey and pollen and another with capped and uncapped brood alongwith bees and the old queen should be taken out of the colony and placed in the new hive after destroying any queen cells present on the brood frame. The old hive with the rest of the brood, honey frames and bees should be removed to a new site 30 yards away after destroying all but one queen cell. When no queen cell is present* a ripe queen cell from another colony should be introduced. If a spare young laying queen of a desirable strain is available, it should be introduced into the old hive after destroying all queen cells. The old hive should be examined

*The bees can be left to raise a queen for themselves from an egg or a young larva in one of the combs, but this method in addition to being slow often results in an inferior queen.

after about 10 to 16 days to find out whether the young or the newly emerged queen, as the case may be, is laying eggs.

(*b*) GREATER DIVISION: Boxes (nuclei) big enough to hold three frames are specially made. Two frames of capped and uncapped brood along with the bees are taken from the colony to be divided and placed in each of the nuclei. An additional frame of honey or a drawn-comb is given to each. The nuclei are closed at the entrance and the top with wire gauze and placed in a cool, dark room for about 24 to 48 hours. Then, they are placed in the apiary at different sites and wire gauze cover removed from the top (and replaced by an inner and outer cover) and entrance. A ripe queen cell in a queen cell protector (Fig. 43) or a virgin or a mated queen in a queen introducing cage (Fig. 32) is given to each. Those without honey are fed sugar syrup. The nuclei are examined within 10 to 16 days to see if the queens have started laying eggs. Such a heavy increase is undertaken only when it is desired to increase the number of colonies and not to produce surplus honey.

(*c*) ONE FOR SEVERAL: When the colonies are rearing brood at a rate faster than normal and there are chances of the 'swarming instinct' becoming dominant in the honeyflow period, one or two frames with capped brood along with the adhering young bees* are taken each from several colonies and placed in a new hive on the stand of another colony which is shifted to a new site. A ripe queen cell in a protector or a queen in an introducing-cage is put in the new hive and work of the queen checked up after 10 to 16 days.

This method helps to check swarming, but does not weaken the colonies. The bees are able to take full advantage of the honeyflow.

Uniting. In the foregoing pages it has often been advised that weak colonies should be united to others which also need help. As each colony has its own peculiar odour, it is necessary either to blend the odours of the two colonies slowly or to suppress both odours by a stronger one. If this is not done, the bees of the two colonies fight, with the result that a large number of them are killed. The colonies to be united should be brought near each other

*There is no fighting among young bees from different colonies. As a precaution, smoke may be applied.

by moving them closer about three to six feet each day so that the field bees may not drift back to the old site. When the colonies are sufficiently close, either the newspaper plan or the smoke method described below should be used. If the quality of the queens heading the two colonies is known, the better queen should be saved and the other colony rendered queenless. The latter queen, however, should be saved until the time it is known that the chosen queen has been accepted by the united colony. When the beekeeper has no clear idea of the performance of the queens both colonies with queens may be united with their queens intact. Generally, the younger and the more vigorous queen vanquishes the other. Uniting should be done late in the afternoon.

(*a*) NEWSPAPER PLAN: A few holes are made in a newspaper sheet with a small nail. It is placed over the brood chamber of the queen-right colony. The brood chamber (without the bottom board) of the other colony should be placed above it. The bees will gnaw through the sheet and intermix in about 24 to 48 hours, when the extra brood chamber may be removed and the frames of both the colonies alternated.

(*b*) SMOKE METHOD: (*i*) *Uniting swarms:* Often small truant swarms from outside are caught and it is desired to unite them or a swarm is to be added to an established colony. The swarm and the colony (or the two swarms) should be smoked heavily and the former should be dumped into the latter (or the two swarms together in a hive). More smoke should be blown into the hive. Then sugar syrup scented with oil of peppermint or wheat flour should be sprinkled over the bees and the hive closed. The work of the surviving queen may be checked up after three or four days.

(*ii*) *Uniting colonies:* When the two colonies to be united have been brought close to each other, both should be smoked heavily and thin sugary syrup scented with oil of peppermint or wheat flour sprinkled over them. The combs with the bees of the colony to be united should be alternated with the combs of the other colony. More smoke and syrup or flour should be applied and the colony closed. The work of the queen may be checked up after three or four days.

It is better to unite a laying worker colony to several strong colonies by giving from one to two frames to each of them. If all

its frames are united to one colony, there is a danger of the latter's queen being killed by the laying workers.

Feeding Methods. Honey is the best food for bees and the beekeeper should leave enough of it with them at all times. However, artificial feeding becomes necessary, among others, during droughts, at the time of making artificial increase, hiving swarms, packing the bees for winter, and to small nuclei. The best substitute for honey is syrup made from white crystalline sugar. The use of *gur*, jaggery, molasses, etc. is not recommended as these substances ferment in the cells and also cause dysentery.

The consistency of the syrup should be two parts sugar in one part water [tartaric acid (cream of tartar) may be added at the rate of five grains per lb. of sugar] for feeding before winter and one part sugar and one part water at other times of the year. Sugar crystals should be thoroughly dissolved in water, if necessary by heating the mixture. A fine-grained candy can be made by heating two parts of sugar and one part of water (with 5 grains cream of tartar per lb. of sugar) and stirring the mixture continuously until a temperature of 240°F is reached. The syrup should be allowed to cool to 140°F when vigorous stirring may be resumed. It should be continued until the material becomes fluid after an initial stiffness and looks milky white. It may then be poured in cardboard moulds and candy cakes about one inch thick may be prepared.

Sugar syrup should be given to bees in a feeder. An ordinary wide-mouthed bottle (or a tin can) of three to five lb. capacity, with a few holes in its cover and overturned over the frames or a division board feeder will serve the purpose very well. Syrup can also be fed in small dishes with a few floating straws. The bees will sit on the straws and suck the syrup. Leaking feeders should not be used. Wood containers should be soaked in water for six to twelve hours before use. Great care must be taken not to provoke robbing in the apiary.

Fine grained candy may preferably be fed in the humid and cold weather by placing about one-inch thick slabs of it over the frames. Feeding thin syrup in an open vessel to simulate a honey-flow or to induce the bees to rear brood is not recommended as it results in a general furore in the apiary which starts robbing among the colonies.

Moving Bees. Often it is desirable to shift a colony a few yards in the apiary. It must not be shifted at once because the field bees will return to the old site. It should be moved three to six feet every day late in the evening towards the desired site. To enable the foraging bees to recognise their hive on return, a bundle of twigs should be placed in front of the entrance of the hive at the new site.

If, however, a colony is to be moved a few hundred yards in the same apiary, the best plan is to take it to a place three miles away from the apiary (after preparing it as described below), keep it there for about a week and then bring it back to the desired spot.

Many beekeepers undertake migratory beekeeping and take their colonies of bees to new pastures for gathering honey. Sometimes colonies have to be taken to exhibitions or transported back to the home apiary. Bees can stand long journeys well if they are properly prepared. First of all, the movable parts of the hive are stapled or nailed together so that the hive is bee-tight. The frames in the brood chamber are tightly fixed after allowing enough bee-space between adjacent frames and the empty space in it is filled by frames without combs. If self-spacing frames are in use it can be accomplished by nailing the frames on the sides but if non-spacing frames are in use, suitably thick pieces of twigs or wood are inserted between the successive frames to keep the various combs apart and to save the bees from being crushed during transit. Only frames with brood or pollen or a little honey should be so packed. Frames more than half full of honey should be taken out as honey combs cannot stand jolting. Newly-built combs which are even partially filled with honey should be taken out. A deep top screen (made of eight to ten meshes to an inch wire gauze) to provide clustering space should be nailed on the top in place of the inner cover. An entrance screen which should permit a cluster of bees to be formed in it should be nailed in the evening when all the bees have returned home. The hive should be made bee-tight by a liberal use of 'plasticine' or cowdung-clay paste. As already mentioned *Apis indica* bees are poor propolisers and special care is needed before they are taken on a journey. During transit hives can be placed on top of each other but ventilation strips should be provided over the

top screens and between the hives. Water should be sprinkled over the hives during journeys in hot weather. It is desirable to place the hives in a railway carriage with the ends of frames towards the sides of the carriage and in a motor vehicle towards the front and back of the vehicle. The hives should not be left in or exposed to the sun and travelling in hot weather should preferably be done at night.

On arrival the hives should be placed at their new sites and their entrance screens removed. After some time when the bees have oriented themselves, the top screens may also be removed and the colonies examined to remove any damaged or broken combs*. A further examination after a day or two is necessary to check up the working of the queens.

Anti-Robbing Methods. Robbing is the habit of pilfering honey by bees from other colonies. *Apis indica* bees are more prone to this type of lawlessness than their European relations. It is liable to occur during lean periods when there is not much nectar to be had from flowers. At such times, the bees may visit sweetmeat shops, sugar and *gur* depots and canning factories. These easy gains also induce them to discover weak colonies and ransack their honey stores. Similarly faulty hives, spilt sugar syrup, exposed honey, exposed colonies during examination, careless feeding of weak colonies, etc. accentuate robbing tendency among bees.

In an apiary robbing may take place on any day during a lean period. A band of bees from a strong colony goes out 'nosing' the chinks and crevices of the other colonies and on scenting honey the marauders try to enter through openings other than the main entrance which is guarded by the guard bees. If they fail this way the culprits make a frontal attack at the entrance which is, of course, resisted by the guard bees. If the latter are overcome, the robbers and other bees from their colony pillage the vanquished colony. Eventually, the beaten colonies become so demoralised that they themselves carry their honey to the hive of the invaders. The victorious bees rob one colony after another until they meet their match and their undesirable venture is ended.

Both the robber and the robbed colonies suffer heavy casualties

*Much risk is involved in moving brood combs in frames without wires and it should be avoided as far as possible.

and the resultant commotion diverts the attention and interrupts normal working in the apiary. As a result of robbing, bees (*a*) are killed, (*b*) lose their queens, (*c*) produce laying workers, (*d*) are reduced to a pitiable existence and fall an easy prey to their enemies. A beekeeper who is not well-versed in anti-robbing measures often loses all his stock or his bees remain in a state of perpetual starvation.

To prevent robbing it is necessary that the hives should be made bee-proof in the manner explained in the foregoing pages. The entrance holes should be made small to make it easy for the bees to guard them. Sugar syrup should be fed late in the evening in bee-proof feeders inside the hives. No syrup should be spilt and, if spilt, should be carefully washed off with water. Weak colonies should not be fed syrup but should be given candy or honey frames from other colonies. During a dearth period, colonies should be handled late in the afternoon and exposed for as short a period as possible. The beekeeper should try to remove disparity of strength among the colonies by uniting as weak ones tempt others to act 'lawlessly'.

If, in spite of precautions, robbing breaks out, the entrances of all colonies in the apiary should be shortened to one-bee width; a bunch of wet grass or rags soaked in crude carbolic acid, kerosene or phenyle should be placed in front of or near the entrances of the colonies being robbed. One per cent solution of carbolic acid in water should be sprinkled round them. As a last resort the position of the colony being robbed should be exchanged with that of the robber's colony. The robbed colony, after its entrance has been closed with a piece of wire screen, should also be kept in a dark and cool room for three days or removed three miles away from the apiary and an empty hive placed in its place. The sprinkling of wheat flour on the bees coming out of the robbed colony (unusual activity in a weak colony) and following them back to their hives helps one locate robber colonies.

Laying Workers. Laying workers generally scatter their eggs in the brood nest and place them over the sides of the cells and several eggs in a cell (Fig. 62). Often queen cells are built and eggs placed in them develop up to the pupal stage, but the creatures are still-born.

Such colonies do not accept queen cells or queens by the usual methods and it is best to unite them with several strong colonies by giving the latter a frame or two each. If all the frames are given to one colony there are chances of its queen being killed by the laying workers. A major portion of the laying workers can be caught and destroyed by shaking all the bees on a sheet of cloth about ten yards away from their hive. The non-laying workers will fly back quickly to the hive, but the laying ones being heavier in the belly, will only hop about and can be captured.

Drone Layers. An improperly mated queen, or an injured virgin which has been unable to fly and to get mated lays eggs which develop into drones only. Similarly, an old queen, whose stock of sperms has depleted lays eggs from which only drones develop. Such queens should be replaced.

Supersedure. The old queen from the parent colony accompanies the primary swarm during the swarming period. In nature, it is not possible to replace her during the swarming period. However, when the bees notice the failings of their queen, they take steps to supersede her with a new queen. Two or three large queen cells, unlike a dozen or more comparatively small queen cells during the swarming period, are raised generally in the centre of the brood nest at the middle (not edges) of a comb. One of the virgins, gets mated and starts laying eggs. Often a mother and her daughter are seen laying eggs on adjacent combs but eventually the old queen disappears.

Supersedure is often noticed in autumn but is practised at other times of the year also. Queens raised under the supersedure impulse are plump, strong and good layers and should be preferred to those raised under the swarming impulse.

Queen Rearing. The modern beekeeper cannot wait for the natural supersedure of failing, decrepit or otherwise undesirable queens and should always have a stock of spare mated queens of a good strain. Spare queen cells are available during the swarming season and can be given to nuclei (Fig. 65) for getting the queens mated, but as stated before, the queens produced under the swarming impulse are comparatively poor with the swarming instinct dominant in the colonies headed by them and hence this method may be undertaken as a last resort.

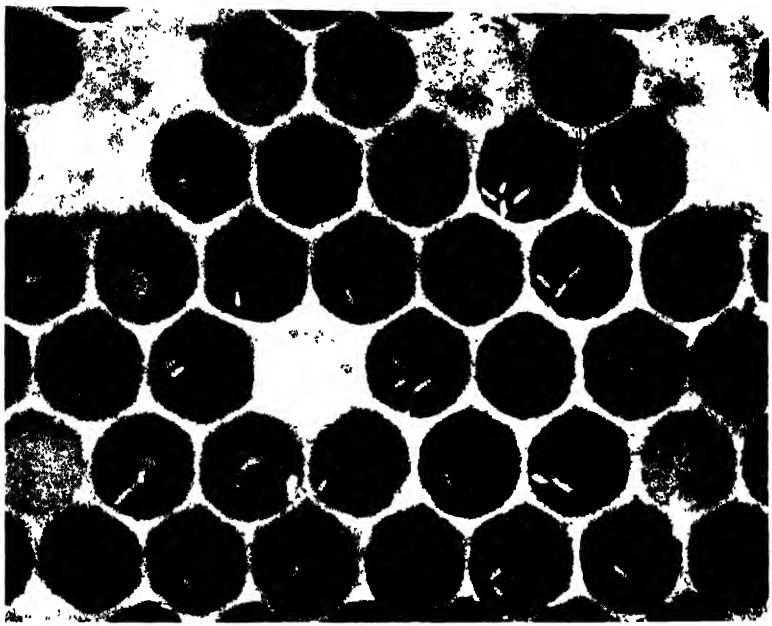


Fig. 62. Eggs laid in cells by laying workers. Note the haphazard placement of several eggs in a cell (Grout

Fig. 63. A honeybee comb damaged by caterpillars of the Greater Wax-moth

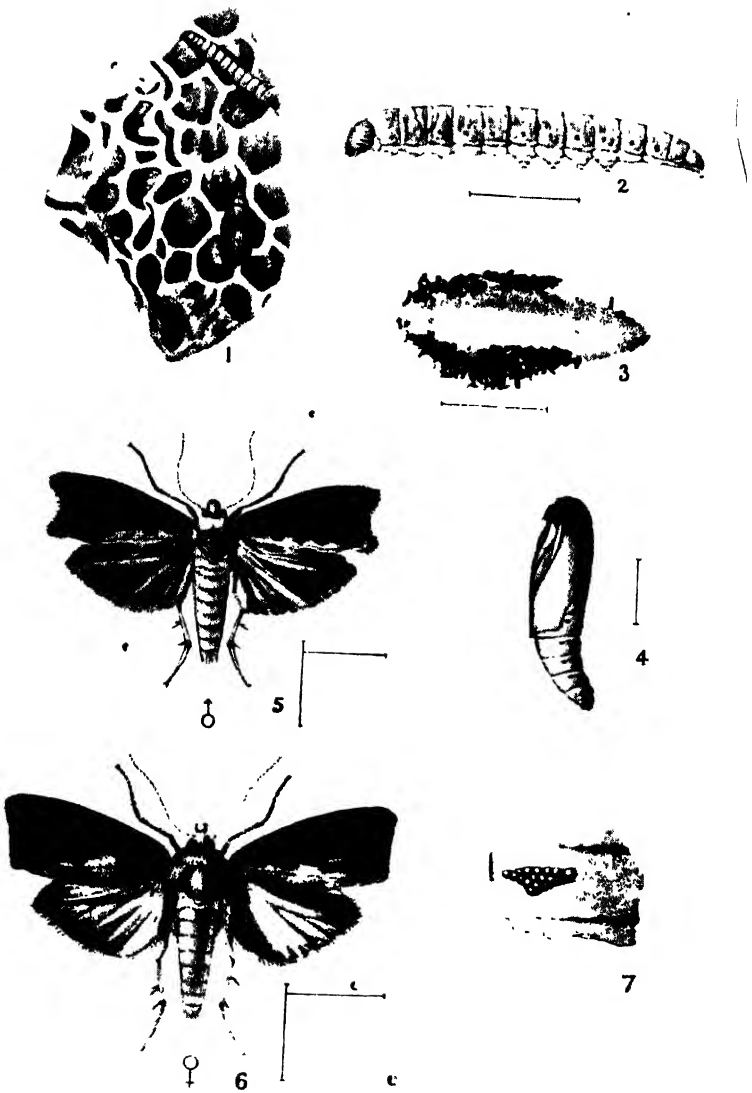


Fig. 64. Greater Wax-moth (*Galleria mellonella*) : 1. Piece of comb showing eggs, caterpillar and moth in resting position; 2. Caterpillar (full grown); 3. Cocoon; 4. Pupa; 5. Male moth; 6. Female moth & 7. Cluster of eggs.

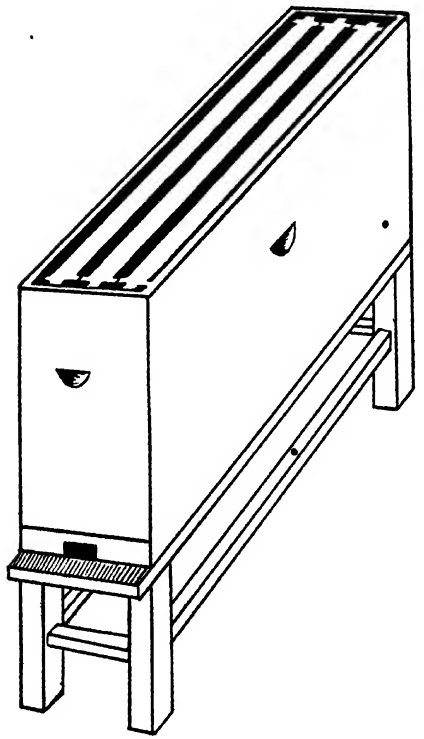


Fig. 65. A three-frame nucleus for queen rearing

Queen cells can also be produced by removing the queen from a strong colony of a desirable strain, introducing the cells raised by the colony into nuclei for getting the queens mated. By this method only a small number of spare queens can be produced. For producing a large number of queen cells, a day-old larvae from worker brood cells of a colony of a desirable strain are grafted by special transferring spoons or needles into artificial cell cups with thinned royal jelly (Fig. 66) and given to strong queenless colonies from which all queen cells have been removed to raise queens in the cell cups. These cells are then given to the nuclei and queens mated. This last method is an art and those proposing to practise

it should study special treatises on the subject published in the U.S.A.*

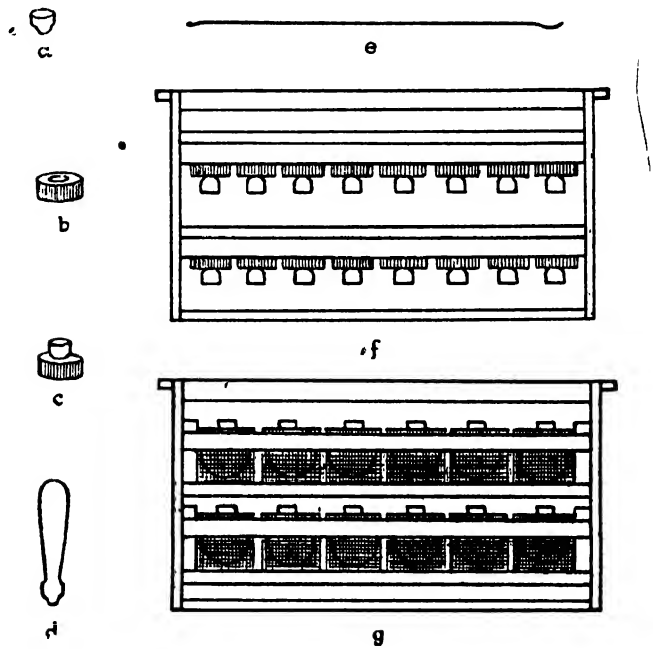


Fig. 66. Some apparatus for queen rearing (Pellet): a. wax cell cup; b. wooden cell cup; c. wax cell cup in position in wooden cell cup; d. wooden mould for forming wax cell cups; e. grub transferring needle; f. bars with cell cups in position in a frame and g. queen emergence cages with ripe queen cells in position in a frame

Requeening. Good queens are a pre-requisite of successful beekeeping for all the members of the colony are her progeny. Her disposition and qualities and those of the drone with which she mates are inherited by the workers who do most of the work in the colony. The qualities to seek, among others, are gentleness, prolificness, industriousness, ability to resist enemies and diseases, tendency to swarm less, absence of absconding, etc. Prolificness or ability of egg-laying is largely a matter of breeding but is also

*Pellet, F.C. (1945) *Practical Queen Rearing*, p. 102; Jost & Kiefer Printing Co. Quincy, Illinois.

influenced by the age of the queen or quantity of eggs already laid by it. Thus requeening has to be resorted to for the improvement of the strain in the apiary as well as to replace failing queens. Often queens are lost as a result of robbing, careless handling during examination, uniting of a laying worker colony, etc. With successful beekeepers annual requeening is a standard practice and queens reared under the supersedure impulse are introduced in all the colonies regularly.

To receive a queen, a colony must be queenless and aware of its own condition. If a new queen is to be introduced in a queen-right colony, it is made queenless and allowed to remain so for six to 12 hours. (Fig. 42). Any queen cells built by the bees to rear their own queen should be removed. Requeening is best done in the honeyflow season. A colony that has neither a queen, nor queen cells nor larvae about two-day old from which a queen could be raised may be termed 'hopelessly' queenless and should be requeened immediately, taking special precautions. Beginners may refrain from requeening laying worker colonies as the chances of their success are meagre indeed.

The queen to be introduced should be put in a queen introducing cage (Fig. 32) with a few attendant worker bees and its holes filled with candy prepared by kneading powdered sugar in honey. The cage should then be placed between two frames (one of which may preferably have brood) of the queenless colony to enable the queen to acquire the hive odour. The bees will eat up the candy in about two days and release the new queen. Her work may be checked up after about a week.

The new queen can also be introduced with the help of a simpler queen cage (Fig. 42) by imprisoning her on a brood comb and enclosing under it honey, pollen and ready-to-emerge worker brood. The newly emerged worker bees will take care of the queen who will acquire the hive odour in about two days after which she should be freed so that she can undertake her egg-laying activities.

In the absence of queens, ripe queen cells in queen-cell protectors can be given to queenless colonies. If they also are not available, a frame with both capped and uncapped (eggs and one or two day-old larvae) brood should be given to the needy colony to enable it to raise its own queen cells and rear a queen.

Clipping a Queen. One or more wings of a queen are often clipped to make it easy to spot her for calculating her age, for knowing whether the bees have superseded the old queen or reared a new one or for checking the total loss of primary swarms or absconding colonies. It is a useful practice in the hands of vigilant beekeepers but with careless beekeepers it may result in damage to good queens during the process of clipping or in their total loss at the time of swarming or absconding.

At the time of clipping of its wings a queen should be picked up by her wings or the thorax only (Fig. 67). In no case her abdomen

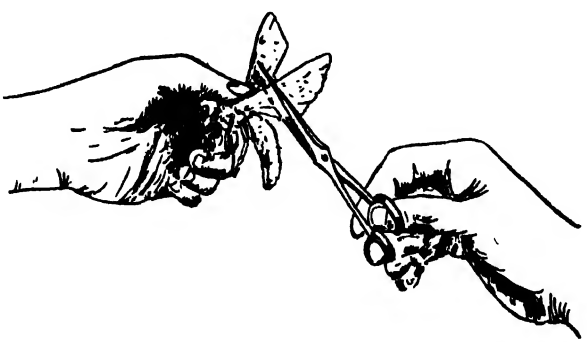


Fig. 67. Clipping a queen's wings

be touched or the legs handled. A sharp scissors may be used for clipping off a wing. In the first year the right front, in the second the right back, in the third the left front and in the fourth the left back wings may be clipped. This system, or a variation of it, will indicate the true age of the queen.

Package Bees. Package bees are artificially produced swarms. Surplus worker bees from colonies are shaken into specially made boxes covered by wire gauze (Fig. 68) through funnels on which are placed queen excluder sheets to keep out the drones. The packages contain weighed amounts of bees, say two, three or five lb. and may or may not be accompanied by a queen. Package bees are produced in localities where colonies build themselves up to a sufficient strength early in the spring. Packages are forwarded to other regions to replace winter losses, to increase the number of

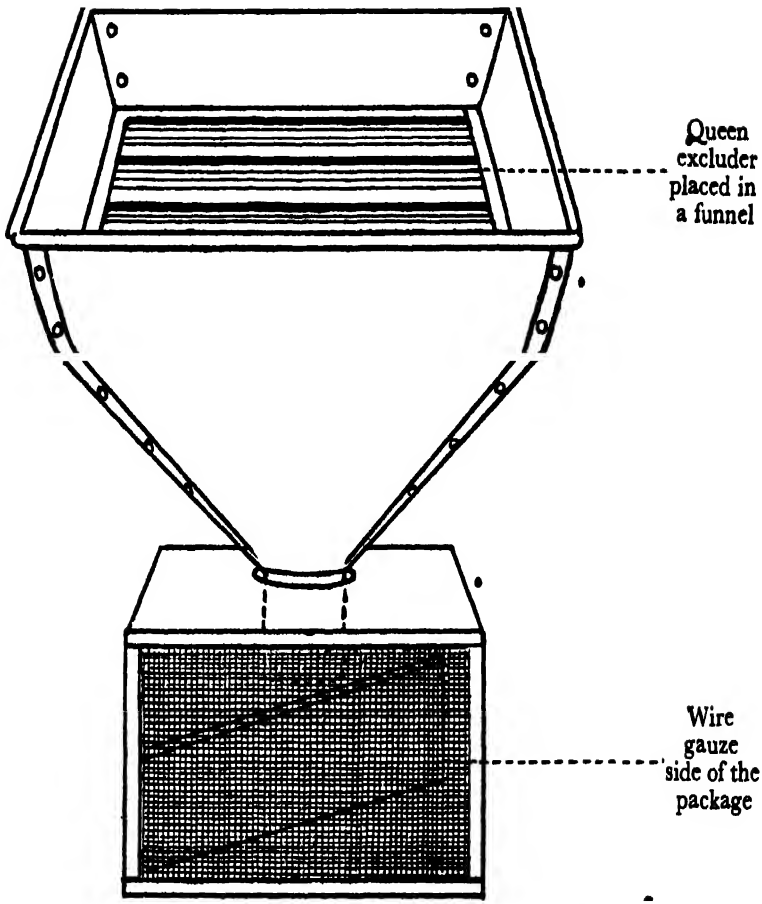


Fig. 68. Equipment for filling a package of bees

colonies, to help comparatively weak colonies and to stimulate pollination of fruit trees and vegetable plants. The package bee industry has not developed in this country but is well established in the U.S.A.

CHAPTER 10

ENEMIES AND DISEASES

HONEYBEES are subject to the depredations of a large number of enemies and diseases both of the brood and the adults. Bee diseases are a major source of trouble in the West. Everything possible should be done to keep them out of the country because these diseases may wipe out the Indian beekeeping industry. Recently acarine disease of adult honeybees has been reported from the Kangra and Simla Districts of the Punjab, parts of Himachal Pradesh and Kumaon Hills of Uttar Pradesh. A brief account of bee diseases is given at the end of this Chapter to acquaint the beekeeper with knowledge which may be needed any time. In India bee enemies are active and take a heavy toll of bee life. A large number of desertions of hives by bees is due to their nefarious activities. Bee enemies may be studied under such heads as wax-moths, wax-beetles, wasps, ants, birds, and the miscellaneous group.

Wax-moths. The Greater Wax-moth—*Galleria mellonella* L. is by far the most serious threat to combs. While it is discussed in detail, brief mention is also made of a comparatively minor pest—the Lesser Wax-moth—*Achroia grisella* (Fabr.). Then there are caterpillars of several other moths* that are noticed in combs, but their damage is occasional and they do not occur widely.

Greater Wax-moth. IDENTIFICATION : Adults: Brownish grey; 10 to 18 mm. in length; wing expanse 25 to 40 mm; the female larger than the male. The colour and size of adults varies a great deal in accordance with the food eaten during the larval period; dark brown combs containing pollen give rise to darker and bigger adults. The outer margin of the front wings of the males has a semi-lunar notch, whereas that of the female is smooth (Fig. 64).

*The Mediterranean flour moth—*Ephestia kuhniella* (Zell.); the fig moth—*E. cautella* (Walk.); the Indian meal moth—*Plodia interpunctela* (Hbn.); the dried fruit moths—*Vitula serratilineella* (Rag.) and *V. edmansii* (Pack.); and moth from bumblebee nests—*Aphomia sociella* (L.).

EGG : Spherical, smooth, creamy white, 0.4 to 0.5 mm. in size and laid in clusters hidden in cracks and crevices in the hive and of the comb and only occasionally on open surfaces.

CATERPILLAR : Freshly hatched larva is white and 3 mm. in length; full grown is dirty grey and up to 30 mm. long; its brownish head is conspicuous. They live in the silken tunnels spun by themselves.

PUPA : The young pupa is brownish white and the old is dark brown; 14 to 16 mm. long; pupal case usually white, often covered by scattered pieces of faeces and frass, up to 28 mm long. The cocoons usually form a mass strongly webbed together in rows or tiers, sometimes actually carved in the wooden parts of the hive.

DISTRIBUTION AND FOOD : The Greater Wax-moth occurs all over the world and its ravages are known from very old times. In the plains and lower hills of India it presents a serious threat to the three species of Indian bees but is rare at higher altitudes. Its caterpillars eat old combs, propolis, pollen, cast larval skins and other such protenaceous matter but they cannot live on pure beeswax. They have no use for honey or brood. They may tunnel through newly built comb (pure beeswax) but gradually shrink in size and eventually are starved to death because they cannot digest pure beeswax. They eat the comb to derive nourishment from the impurities in the beeswax.

LIFE HISTORY : The males and females mate within a day of their emergence and females enter the hive usually at night when the bees are not active but occasionally during the day in the case of weak colonies. The female starts laying eggs in clusters one or two days after mating and up to a thousand or so eggs may be laid by it in its lifetime of about a couple of weeks. The males are known to live for about three to four weeks. The incubation period of the eggs varies from a week to 18 days depending upon temperature. The eggs cannot stand temperatures below 60°F and above 95°F. Young caterpillars are exceedingly active and eat gnawed pieces of comb and other *debris* on the bottom board or nibble at small pieces of comb. They soon spin silken tunnels in the comb or tubular galleries on the bottom board to protect themselves. If the food on the bottom board is not sufficient, they migrate to the combs and move towards its midrib. The caterpillars cast off their skins

four to six times. How long they live depends upon the temperature and abundance of proper food; the period varying from four weeks to five months. The pupal stage may be anything from a week to eight weeks depending upon temperature. The total life cycle may be completed in six weeks to six months. At normal temperatures available in the hive during the active season (85° to 95°F) an egg may become an adult in about seven weeks.

SEASONAL HISTORY : There are several overlapping generations of the pest in a year depending upon temperature, the availability and nature of food and whether the pest is in an inhabited hive or stored combs. In localities with comparatively warm winters, all stages of the pest (adults also) are met with in hives throughout the year. In stored combs, the pest hibernates in the caterpillar stage (about 70 per cent) and in the pupal stage (about 30 per cent). No adults are to be found. The pace at which caterpillars grow, even in warm localities, considerably slows down in winter and the pest is active from March to October. The emergence of adults starts in March and April.

NATURE AND EXTENT OF DAMAGE. The caterpillars eat away combs or damage them by making silken galleries with their side tunnels near their midribs. The first indication of the entry of the larva in the comb is the presence of small masses of minute particles of wax outside the holes. Later, faint webbings are perceptible over some cells of the comb. When infestation has progressed far enough, silken tunnels with caterpillars wriggling in them are noticed and eventually the whole comb is a mass of webbings in which the excreta of the caterpillars is enmeshed (Fig. 63). In severe cases of infestation, further brood rearing is stopped, field work is virtually suspended and the colony deserts its home, to seek its fortune elsewhere, leaving it to the intruders.

Almost all colonies of *Apis indica*, *A. dorsata* and *A. florea* bees are infested with this pest chronically and the caterpillars actively sabotage or undo the work of the colonies continuously. They suddenly acquire a dangerous importance during a dearth period and the monsoon, and make the colonies desert their nests. Infested colonies in hives, stored combs, improperly cleaned beeswax and wild colonies or deserted combs of *Apis dorsata* and *Apis florea* bees are a constant source of infection. In the case of newly established

swarms or colonies the culprit is the female moth which enters the hive and lays eggs. Unless the beekeeper is vigilant in removing the caterpillars and keeping the hives clean, any colony may succumb to their activities.

PREVENTION AND CONTROL : Though any colony is liable to be attacked by this pest, strong ones usually are able to resist it. Their resistance can be increased by keeping the hives tight-fitting and by obliterating the cracks and crevices with a mixture* of rosin and puttie used for fixing glass panes or moulding clay (plasticine) or beeswax. Hive entrances should be reduced to widths which can be easily guarded by the bees. The suggestion for keeping surplus combs on the colony made in regard to European bees is apparently not applicable to *Apis indica* bees for even some strong colonies may have the caterpillars on the bottom boards and in drawn combs (which are not covered by the bees) in the super. Hence all combs which the bees do not cover should be removed particularly during a dearth period. During the normal examination of colonies every week or in ten days' time, the *debris* (gnawed pieces of comb, fallen wax scales, loose pollen pellets, any dead bees or their parts) on the bottom board should be scraped clean with the hive tool and any infested combs removed. Tunnels of wax-moths in a comb can be seen if it is held against the rays of the sun. Weak colonies should be strengthened by adding brood frames and their queens replaced.

All *debris* from the hive should be destroyed except on rare occasions when the population of the parasites is sought to be enhanced. As far as possible deserted combs of wild bees should be collected and made into wax along with burr and brace combs, infested combs and odd pieces of beeswax. Beeswax and comb foundation in stock should be kept in tight containers. All spare drawn-combs should be kept in empty hive bodies in tiers and closed both at the bottom and top. The joints of hive bodies should be covered by gummed tape or wet clay and the stacks of four to five hive bodies kept mothproof. The new stacks should be disinfected with sulphur fumes by burning sulphur over live charcoals

*The Indian bees which are very poor propolisers, compared to the Italian bees not to speak of the Caucasian bees, do not fill up the chinks and crevices of the hive body and have to be helped in this respect by the beekeeper.

at the rate of 1 oz. for 3½ cubic feet of space. Calcium cyanide (1 oz. per 10 cubic feet), carbon disulphide* (1 oz. for 6 cubic feet) or ethylene dichloride—carbon tetrachloride mixture (1 oz. for 3 cubic feet) and methyl bromide (1 oz. for 30 cubic feet) can also be used for fumigating the combs. Fumigation has to be repeated to kill the newly hatched caterpillars from the eggs which resist the fumigants except methyl bromide which even kills the

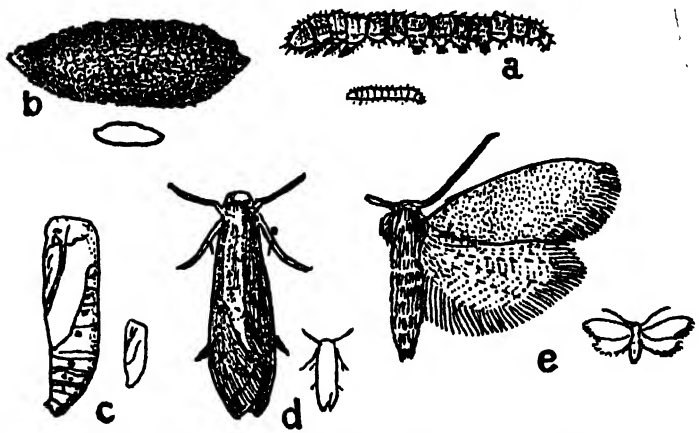


Fig. 69. Lesser Wax-moth (*Achroia grisella*): a-caterpillar; b-cocoon covered with pellets of excreta; c-pupa; d-moth in repose; e-moth with wings spread. The figures in outline show natural sizes

After fumigation, the combs should be stored in moth-tight hive bodies and para-di-chlorobenzene (PDB) crystals (1 oz. per 2 cubic feet) should be spread on the top. Naphthalene flakes at double the rate of PDB can also be used. Greater Wax-moth caterpillars and caterpillars of other wax-moths are parasitised by a braconid, *Apaniteles galleriae*. The female parasite lays its eggs singly inside caterpillars and the grubs feed inside them. The total life cycle takes from 16 to 22 days. The average life of an adult is from 11 to 14 days. Parthenogenetic reproduction is often resorted to.

To give a fillip to the parasite population the *debris* collected from the hives should be kept in wire gauze cages on water cups

*All these materials are highly poisonous and fumigation should be undertaken in an open area and with full precautions. In addition, carbon disulphide is highly inflammable, open fires should be kept away from it.

from which the adults of the parasite can fly out but caterpillars and adults of the wax-moth cannot escape. Such cages should be kept in cool shady places in or near the apiary.

Lesser Wax-moth. The adults, larvae and pupae of this moth are smaller (Fig. 69) than those of the greater wax-moth. The egg stage lasts from two to four days, larval from 34 to 48 days, pupal from five to 12 days, and the adults live for about a week. The female moth lays from 300 to 500 eggs in its eight day long life. There are three to four generations during the active season.

This variety of wax-moth is noticed at comparatively higher altitudes than those where greater wax-moth is found. Its caterpillars are more like scavengers as they are usually to be found in the *debris*. They also attack stored combs and usually feed on

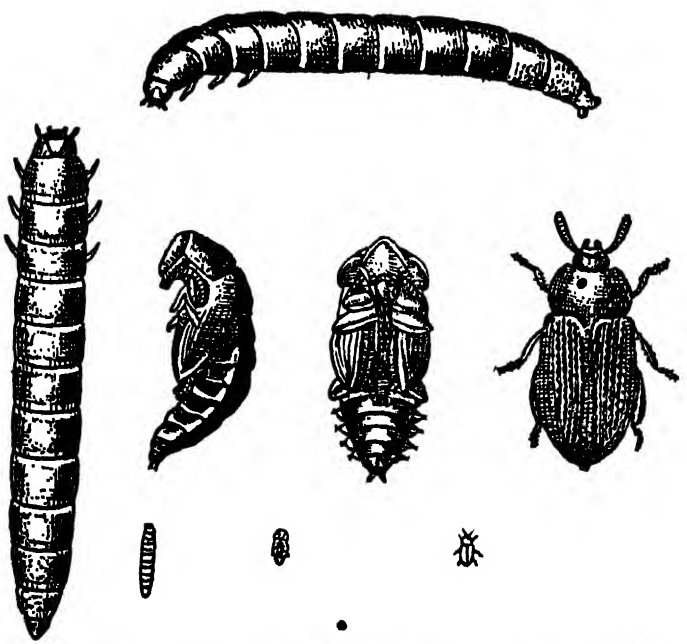


Fig. 70. Wax beetle (*Bradymerus* sp.): *top and left*. grub; *centre*. pupa; and *right*. adult. The figures in outline show natural sizes.

the outer surface. Their webbing is interspersed with dark faecal pellets. They as well as other species of caterpillars which infest combs can be controlled in the same way as the Greater Wax-moth.

Wax Beetle. A tenebrionid beetle—*Platybolium alvearium* (Blair) and its grubs are found among the *debris* on the bottom board or nibbling pieces of an empty old comb in weak colonies. The eggs are laid in crevices of the hive and the incubation period is from four to five days, the larval period from 103 to 120 days, the pupal period six or seven days and the total life cycle is completed in 113 to 132 days. The adults are known to live from 100-180 days. This and another tenebrionid beetle (*Bradymerus* sp. Fig. 70) thrive in unhygienic conditions in the hive and, therefore, regular cleaning of bottom boards and thorough inspection of empty combs will keep them free from these minor nuisances.

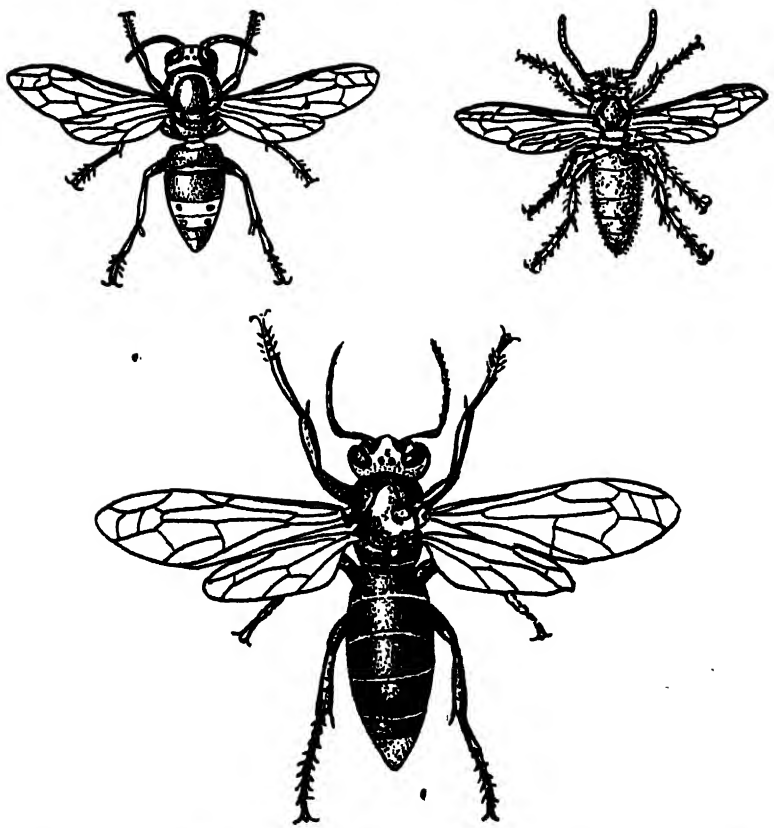


Fig. 71. Yellow banded brown wasp (*Vespa orientalis*)—*top left*; golden wasp (*Vespa auraria*)—*top right*; and large black wasp (*Vespa magnifica*)—*bottom*

Wasps. Several species of *Vespa** are found in the plains (Fig. 71) and hills. They are social insects like bees and build paper nests in cavities of trees, walls, cracks in the ground or hang them down from tree limbs. They are predaceous by nature and catch bees from blossoms or at the entrance of a hive. Weak colonies become their special targets. They make bold to enter a hive and catch their prey from the combs and eventually finish off the colony. Wasps macerate bees and feed their young on a paste-like material.

Fecundated female wasps overwinter and start new nests in spring. The worker wasps on emergence help their mothers and take over the field work. The nests become populous during the monsoon and autumn and new ones are also started by fecundated females in summer. The population of a nest is at its peak during autumn, at the end of which all castes except fecundated females die out. They pass winter under cover in nooks and crevices and start building nests in spring.

The best method to rid a locality of wasps is to kill the fecundated females early in the spring. An earnest effort should also be made to kill them at hive entrances or destroy their nests in the vicinity. Wasp nests can be destroyed by burning them with kerosene torches, fumigation with calcium cyanide**, by spraying 5 per cent benzene hexachloride emulsion or by blowing 10 per cent DDT dust in underground nests. A concerted effort on a cooperative basis will bear fruit. The killing of wasps at hive entrances with fly flappers or wooden strips is a rather costly, time-consuming and laborious though a spectacular method and does not achieve substantial results if practised late in the season. Various baits made of meat, fish and chemicals are not very effective. In addition, chemical baits may attract and kill honeybees.

The Department of Agriculture, New Zealand, has undertaken anti-wasp campaigns in that country. It pays bounties for killing queen wasps caught before the breeding season (over Rs. 15,000/- were paid for the destruction of 56,588 queens in one country in

*Yellow banded brown wasp—*V. orientalis* (L.); yellow banded wasp—*V. cincta* (F.); golden wasps—*V. auraria* (Smith), *V. ducalis* (Smith); and large black wasps—*V. magnifica* (Smith) and *V. basalis* (Smith).

**This deadly poison should be handled by trained personnel and with proper precautions.

1948), distributes poisons free for the dusting of wasps' nests, and also employs part-time workers to destroy them.

The yellow wasp (*Polistes hebraeus* Fabr.) sometimes visits hives and should be meted out the same treatment as above.

The bee-hunter wasps (*Philanthus ramakrishnae* T.) is a pest of the hill bees. In the plains *Palarus orientalis* (Kohl.) becomes troublesome in certain localities. These wasps live singly but nest gregariously in underground tunnels in sandy banks and the shady corners of fields. Each nest consists of a tunnel leading to a number of cells in which four or five bees are stocked and an egg laid on one of them. These wasps visit beehives on bright days from about 11 A.M. to 4 P.M. during hot weather and catch bees at the entrances and paralyse them with their stings. The bees that manage to free themselves from their clutches also die later on.

The placing of bushes in front of hive entrances also reduces the damage from these wasps to some extent as their exit becomes difficult. They can be caught in hand-nets or killed at hive entrances with fly flappers. Their nests should be dug open.

Black Ants. Various species* of black ants visit bee colonies and take away honey, brood, pollen, dead bodies and other *debris*. They hasten the end of a weak colony though strong colonies usually succeed in keeping them at bay. As black ants live in underground colonies, their nests should be destroyed by fumigating them with two to four table-spoons of carbon disulphide or by pouring into them 2-5 gallons of 0.2% BHC suspension or 0.1% aldrin emulsion and sealing them with mud. Bee colonies can be kept free from ants by placing the hives on stands with their legs in earthen cups containing water, used engine oil or tar. Tape soaked in corrosive sublimate and wound round the legs of stands is a good repellent but needs renewing once or twice a month.

Birds. King crows [*Dicrurus macrocercus* (Vielillot) and *D. ater* (Nerm.) Fig. 73.] visit apiaries occasionally on cloudy days, and prey upon bees. They have an otherwise bright record as friends of the

*1. Carpenter ant.—*Componotus compressius* (Fabr.)
2. The small red household ant—*Dorylus labiatus* (Shuk.)
3. *Monomorium indicum* Morell.
4. *M. destructor* (Ters.)

farmer. The bee-eaters [*Merops orientalis* (Latham) (Fig. 72,) and *M. superciliosus* (L.)] do much harm around apiaries. From 6 to 43 honeybees have been found in the stomach of a bird of these species. They sit on trees or telegraph wires near an apiary and pick the bees on the wing. Since these birds are also very useful in keeping down the insect population of a locality, no large-scale measures against them can be recommended. Scaring them away from apiaries by shooting at them with a .22 bore rifle is suggested.

Other Enemies. Occasionally cockroaches come to live in weak colonies and nibble away small bits of combs. A leaf cutter bee [*Megachile disjuncta* (Fabr.)] enters such colonies and gnaws away pieces of exposed combs. The 'death's head' moth (Fig. 74.) *Achrontia styx* (Westw.) enters the hives at night and drinks honey. Robber flies (*Asilidae-Diptera*), dragon flies (*Odonata*) catch bees and queens on their mating flights. The preying mantid *Creobrator gemmatus* (Stoll.) captures bees while they are visiting blossoms. The hump-backed fly—*Megaselia* (*Aphochaeta*) *rufipes* (Meig.) infests chilled brood and the foul smell created by it compels the colony to

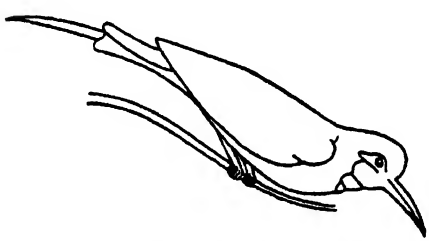


Fig. 72. Bee eater—*Merops orientalis*

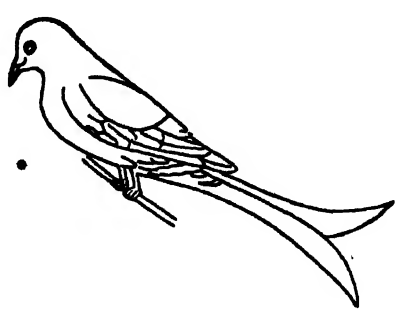


Fig. 73. King crow—*Dicrurus ater*

desert the hive. Pseudo-scorpions (*Chelifer* sp.) are often noticed in beehives. They get themselves carried from the flowers to the hives by clinging to the legs of worker bees. They cause little damage to the colony. Rather they keep them free from wax-moths and mites.

Fig. 71. 'Death's head' moth (*Achrontia styx*) in resting position

Blood suckers, lizards, frogs, toads, etc. pick up bees at hive entrances. Pine martins—*Charonia flavigula* (Bodd.) insert their tails into a hive entrance and eat the bees that get entangled in the hair. Bears break open hives and eat bees, brood, honey and pollen. Rats and mice are the enemies of stored combs or empty combs in a colony particularly in winter. They are tempted to enter a colony because of its warmth. They also eat dead bees, honey, etc.

White ants or termites—*Termes obesus* (Ramb.) are often seen to damage wooden components of hives and other apiary appliances. They are a problem in wall and mud hives also. The stands of hives should be soaked in solignum or painted with a concentrated solution of pentachlorphenol. Liberal coating of coal tar on and around the galleries of termites also acts as a deterrent. These strong smelling chemicals are not liked by bees and should be used on

articles and places which are not to come in close contact with them. Nests of mound forming colonies of white ants can be destroyed by pouring 12 gallons of 0·1% aldrin emulsion into a mound.

BEE DISEASES*

Both the adults and brood of honeybees are affected by various bacteria, fungi, protozoa, mites, etc. leading to partial or total loss of colonies. Most bee diseases are infectious and spread very quickly. In the case of adult bee diseases, the worker bees are the main sufferers. Their strength is sapped and they eventually walk out of the hive to die. In the brood diseases the larvae are killed and get decomposed. The causative organisms of brood diseases do not affect adults and *vice versa.*

The gross symptoms of the adult bee diseases are about the same regardless of the cause and a proper diagnosis is possible only with the help of a powerful microscope. Sick bees are generally unable to fly and can only hop about. Others crawl on the ground, bottom board, entrance board and also climb on the blades of grass. They also collect in small groups in front of the hive. Sometimes the bees drag about their legs as if they are paralysed. The hind wings are unhooked from the front wings and are held at abnormal angles. The abdomen is often quivering and distended. It also appears shiny or greasy.

The nosema disease is caused by a spore-forming protozoan parasite—*Nosema apis* (Zander). It is transmitted by food or water and the spores assume a vegetative form in the stomach and small intestines of the bee which become dull greyish white as compared to the brownish red or yellowish of healthy bees. The spores reflect light and have a glistening appearance under the microscope. This disease is particularly severe during winter and spring and depletes colony populations quickly. It is said to have been reported from most of the major beekeeping areas of the world. No effective measures for controlling this disease are known.

Another protozoan parasite—*Vahlkampfia* (*Malpighamoeba*)

*Information given here is based on the accounts in the 'Hive and the Honeybee', Dadant & Sons, Hamilton, Illinois and various publications of U. S. Department of Agriculture.

mellifica—causes amoeba disease among bees. It attacks the malpighian tubules but its life history has not been fully worked out. It is met with in Europe and America.

The acarine or 'Isle of Wight' disease is caused by a small parasitic mite, *Acarapis woodi* (Rennie) which enters the tracheae or the breathing tubes and feeds upon the body fluids of the bee. The female lays its eggs and rears its young in the tracheae. Eventually the tracheae get clogged with mites and the bee dies. Infection is spread by the mites crawling out of the tracheae and moving on to young worker bees and to other colonies by drifting sick bees and through infected robber bees. The disease is prevalent in Britain, Europe and parts of North-west India and causes heavy losses. It is controlled by exposing the affected colony to several drops of a mixture of safrol oil 1 part, nitro-benzene 2 parts and petrol 2 parts; methyl salicylate or Folbex* strips for a few days. Only the mites in the sick bees are killed but the colony's healthy population is not affected.

Septicemia is caused by a bacterium—*Bacillus apiscepticus* (Burnside) in the blood of bees and is spread through contaminated water getting into the breathing organs. The losses inflicted by this disease are minor and no special measures of control beyond having the bee farm area thoroughly drained are called for.

Fungous diseases in adult bees are caused by *Aspergilus* spp., *Mucor hiemalis* (Wehmer), *Torula* and *Mycoderma* spp. The losses from these are of a minor nature and proper ventilation of the hives keeps these in check.

Whenever bees have to keep indoors for long intervals due to inclement weather or consume unwholesome food like honeydew, and thus have to retain undigested matter in their alimentary canals they void their faeces in the hive. The hive and combs become badly soiled and a disagreeable odour is always present. The disease is known as dysentery and can be cured by removing the conditions which cause it. Paralysis which results in weakness, trembling and the death of affected bees is caused by a filterable virus. It is only

*Heavy paper, 9.5×2.0 cm. in size, soaked in chlorobenzilate manufactured by Geigy Ltd., Basle, Switzerland and marketed in India by Messrs Tata Fison, Bombay.

Table 5. Diagnosis, Cause and Spread of Brood Diseases

Character	American foulbrood	European foulbrood	Para foulbrood	Sacbrood
General appearance of brood combs	Brood irregular; intermingling of capped, open and punctured cells; much dead brood in capped cells; cells with punctured cappings and cells uncapped by bees	Brood irregular; dead brood mostly in open cells.	Brood irregular; most dead larvae in open cells; varying amount of dead brood in sealed cells	Brood slightly irregular; dead brood mostly in cells with punctured cappings or in uncapped cells
Cappings over dead brood	Many punctured, sunken and discoloured	Few cappings sunken, punctured or discoloured	Cappings over dead brood punctured, discoloured, sunken or thickened and sharply depressed in the centre	Usually punctured
Proportion of dead brood	Varying from 1 to 75%	A few coiled larvae to most of the larvae in open cells and a few in capped cells	A few larvae to practically all the brood	Small amount of brood dead
Age at the time of death	Late larval and early pupal stages, rarely coiled stage	Coiled stage, occasionally late larval stage	Coiled stage, occasionally late larval and early pupal stages	Late larval stage; occasionally coiled larval and pupal stages
Position of dead brood	Fully extended on floor of cell, tail turned up on bottom, head lying flat, great regularity	Coiled on bottom or twisted on side walls, few larvae fully extended on floor of cell; very irregular	Coiled on bottom, twisted on side walls or fully extended on the floor of the cell; great irregularity	Fully extended on floor; heads prominently raised, great irregularity

Colour of dead brood	From dull white to dark brown or almost black	From dull white to yellowish white; often dark brown	From dull white to reddish brown	Greyish to straw-coloured to black; head end usually darker
Kind of brood affected	Mostly worker, occasionally drone, rarely queen	Worker, drone and queen	Worker, drone and queen	Usually worker but sometimes drone
Consistency of dead brood	At first watery or slightly viscid, becoming ropy; finally brittle.	At first soft and watery afterwards pasty, rarely viscid and ropy; scales tough, rubbery or brittle	At first soft and watery, in open cells becoming pasty and brittle, in capped cells frequently becoming ropy finally tough and leathery	Skin fairly tough, contents watery and granular, scales tough, brittle when completely dry
Scales	Uniformly extended on lower side wall, tail curved up, dead pupae with tongue extended upwards, often attached to upper cell wall; difficult to *remove from cell*	Usually coiled on bottom of cells; often irregularly twisted, sometimes fully extended; tracheae often clearly visible, tough and rubbery; *easy to remove from cells*	Coiled on bottom; irregularly twisted; on side walls or fully extended in the cell; tracheae sometimes visible; *easily removed from the cell*	Uniformly extended from lower side of wall; head prominently raised; outline wavy; greyish, brown to nearly black; head darker; *easily removed from cell*
Odour	Distinct odour in early stages; gluepot odour in brown ropy remains and scales	No specific odour, sour odour in partly decayed remains; odours variable	Resembles E. F. B. but more intense	Absent or slightly sour
Causative organism	*Bacillus* larvae White	*Bacillus pluton* White and *Bacillus alvei* Dheshire and Cheyne	*Bacillus paraalvei* Burnside	A filterable virus
Spread of disease	Through hive parts, combs, honey	Drifting nurse bees	Drifting nurse bees	Drifting nurse bees

slightly infectious. The affected colonies usually recover after a short time.

Brood Diseases. The brood is attacked by various bacteria, a filterable virus and fungi which take a very heavy toll. The gross symptoms of a brood disease are discoloured larvae, dark cappings, irregular brood (many empty cells scattered about the comb), punctured and sunken cappings. In Table 5 the specific symptoms, etc. of the important diseases are compared.

American foulbrood is the most serious of bee diseases and is very difficult to get rid of once it attacks an apiary. The standard method used in the U.S.A. is to kill the infested colonies and burn the bees, combs, hive and hive parts, though efforts to evolve resistant strains of bees are being made. Use of sulpha drugs as disinfectants is also being tried. Its appearance in India is to be greatly dreaded for wild migrating colonies of the three species of bees would spread the disease like a jungle fire and the industry may be wiped out. European foulbrood is a disease of weak colonies and peculiar to certain races of bees. It can be eradicated by requeening the colonies with the Italian race of bees. Parafoulbrood is closely related to European foulbrood and can similarly be controlled. Strong colonies, good management and requeening weak colonies with Italian queens are effective measures to check sacbrood.

Fungous diseases (Mycosis) are caused by a yellow green spore-forming mould—*Aspergilus flavus* Burnside and other related species. Another fungus—*Pericystis apis* Massen causes chalk brood. The affected larvae become dull white (as compared to glistening white healthy larvae) and harden within a few hours of death. Good management practices will keep such infections in check.

Sometimes brood gets chilled or is starved due to the sudden onset of cold weather and the bees throw out the dead larvae and pupae. The remedy lies in keeping colonies strong, well provided with honey stores and properly protected against inclement weather. Occasionally bald-headed (without cell cappings) pupae are noticed. If uncapped cells are in lines, it may be suspected that wax-moth larvae are working in the combs, but if they are scattered and the pupae are normal, no notice need be taken of such an irregularity.

Sometimes dead brood and dead bees may be found in the hive

as a result of the bees having visited poisonous plants or having been poisoned with insecticides dusted or sprayed on crops in bloom. In California *Solanum nigrum* L., *Aesculus californica* Nutt., *Zygadenus venesosus* (S. Wats), *Cuscuta* spp., *Cyrilla racemiflora* L., *Kalmia latifolia* L., *Veratrum californicum* Durand and *Gelsemium sempervirens* Ait. are suspected to be poisonous to bees. The honeybee is susceptible to most of the insecticides used as stomach or contact poisons or as fumigants in controlling insects. Insecticides should not be used on the crops (which are visited by bees) at their blooming time. Further, drifting of insecticides to fields other than those they are applied to should not be allowed. This can be accomplished by the use of better application machinery, canvas drags between dusting machines and use of comparatively coarse particles of the chemicals.

CHAPTER 11

HONEY AND BEESWAX

HONEY was one of man's first foods and the first available sweet. It has been highly valued by Indians from time immemorial. It has been defined as 'an aromatic, viscid sweet material derived from the nectars of plants through the collection of honeybees and modified and stored by them as a denser liquid'. It consists chiefly of two simple sugars, dextrose and levulose, the latter more predominant, and occasionally contains more complex carbohydrates, moisture, ash (mineral matter) and some plant colouring matter, acids, enzymes, vitamins and pollen grains.

Honey is a natural, unrefined food and is the only unmanufactured sweet available in commercial quantities. It has as many tastes and colours as the flavours and colours of plant nectars from which it is derived. Honeybees visit only one source at a time and keep on visiting it until it dries up. In a locality where several minor honeyflows occur in a certain period, a colony may gather nectar from several sources and the beekeeper may produce a natural blend of several distinct flavours. Since at one time blossoms of a particular source predominate, it is generally possible to produce honeys by far the major portion of which is derived from the nectar from a single source like mustard, soapnut or barberry.

Chemical Composition. As stated above, the bulk of honey is simple sugars and moisture. Some sucrose (table sugar), dextrins and gums also occur. In its ash are found the compounds of silica, iron, copper, manganese, chlorine, calcium, potassium, sodium, phosphorus, sulphur, aluminium and magnesium. Acids like formic, acetic, malic, citric, succinic and amino; plant colouring matter like carotin, xanthophyll, anthocyanin and tannin; and pollen grains and beeswax particles are found in honey. Enzymes like invertase, diastase, catalase, inulase and vitamins A, B complex (B_1, B_2, B_6, H, Folic, nicotinic and pantothenic acids) and C occur in it in varying quantities. The composition of representative honeys from different regions are given in Table 6. For a wider comparison, figures for American and English products are also given.

It may be mentioned that honey is prized for its delicate flavour and fragrance which can better be enjoyed than described. But its real value lies in simple sugars found in large amounts in it. They do not tax the digestive system, are directly assimilable and are a ready source of bodily energy. The quantities of amino-acids, mineral matter, enzymes and vitamins present in an ounce or two of honey, the quantity taken by a person in a day, are too small to become a regular supply of these substances to the human system. Their presence is not the major consideration for which honey is valued. They are of some use.

Its colour and taste are no guides to the purity and quality of honey. Honey from *Plectranthus*, soapnut and white clover is light (almost water-white) in colour and mild in flavour; that from mustard looks yellow and has a little pronounced flavour and that from *shisham* (*Dalbergia*)* is dark amber and strong in flavour. Barberry and buckwheat honeys are very dark in colour and have a strong taste. The flavour of barberry honey is suggestive of molasses. It is said that a person likes that honey best which he took in his childhood. As honey available in the market varies from time to time, *connoisseurs* should ensure a regular supply of their favourite brand from a particular beekeeper season after season. In cold weather, honey usually solidifies, that is, forms into grains. Such granulation is the best evidence of its purity. If liquid honey is preferred, it can be melted by keeping the container in hot (140° to 160°F) water for some time. In the West, honey in the comb either as section or chunk honey is used on the table but a similar use has not become popular in this country where liquid, ungranulated honey is relished.

Honey as Food. It is estimated that 7 oz. of honey is as nourishing as 2½ lb. of milk or 56 oz. of cream cheese, or 12 oz. of meat, or 15 oz. of boneless codfish or 8 oranges or 10 eggs. It is a rich energy-giving food and with milk forms a perfect food. This fact was given a practical test by Dr. Haydak* of the University of Minnesota. He lived on honey and milk with an occasional glass of orange juice for 12 weeks doing normal work without any ill effects. It is highly appreciated as food for infants, the aged and invalids both in this

*Haydak, M. H. (1938) Gleanings in Bee-culture. **66**: 624.

Table 6. Composition of Honey

Description of honey	Reported by	Moisture %	Glucose %	Levulose %	Sucrose %	Ash %	Acidity as formic acid
Indian—average of 61 samples	Das & Bose (1946), Ind. Jour. Agric. Sci. **16**: 405	19·19	32·82	37·95	1·66	0·29	0·10
Coorg—average of 12 samples	Giri (1938), Mad. Agric. Jour. **26**: 68	19·16	35·68	39·3	0·68	0·17	..
Punjab—average of 44 pure samples	Trehan-Note to I.C.C.R., 1950	16·43	34·71	38·74	3·18	0·362	0·13
Punjab—average of 36 market samples	-do-	19·25	33·67	37·42	4·16	0·264	0·11
Mahableshwar	Daji & Kibe (1940), Ind. Bee Jour. **2**: 62	19·62	30·08	41·37	1·60	0·21	0·13
Jeolikote (U.P.)	Muttoo (1940), Ind. Bee Jour. **2**: 125	19·10	76·91		0·85	1·06	0·23
Cotton (Coimbatore, Madras)	Ramachandran (1952), Bee-keeping in South India	14·89	73·96		5·84	0·47	
Cotton (1952) (Coimbatore, Madras)	Ann. Rept. I.C.A.R. Bee Res. Sta. Coimbatore, 1951-52	21·99	69·68		6·96	0·22	0·07
Gliricidia (1952) (Coimbatore, Madras)	-do-	23·57	63·95		7·91	0·15	0·09

Table 6. *Contd.*

Description of honey	Reported by	Moisture %	Glucose %	Levulose %	Sucrose %	Ash %	Acidity as formic acid
Neem (1952) (Comibatore, Madras)	Ann. Rept. I.C.A.R. Bee Res. Sta. Coimbatore, 1951-52	22·88	69·16		7·46	0·06	0·10
Barberry (1944) (Katrain, Punjab)	Singh (1948), Iowa State Apiarist. Ann. Rept. 1948: 34	19·00	75·60		2·90	0·128	..
Plectranthus (Oct. 1940, Katrain, Punjab)	-do-	15·00	38·40	40·0	3·30	0·31	..
Plectranthus (average of 8 samples Oct. 1948, Katrain, Punjab)	Ann. Report Central Bee-keeping Res. Station 1948-49	14·87	35·35	41·21	2·15	..	0·15
Soapnut (May 1939 crop, Nagrota, Punjab)	Agri. Chemist, Pb. (Unpublished)	15·43	35·40	41·80	5·39	0·30	..
Soapnut (May 1945 crop, Nagrota, Punjab)	Ann. Report Cent. Beek. Res. Stat. (1945-1946)	17·0	78·1		4·94	0·14	0·18
Mustard (Feb. 1943 crop, Lyallpur, Punjab)	Agri. Chemist. Pb. (Unpublished)	20·95	33·9	38·7	nil	0·18	..
Dalbergia (April 1943 crop, Lyallpur, Punjab)	Singh (1948) Iowa State Apiarist Ann. Report, 1948:34	18·75	34·6	39·1	1·04	0·18	..

Description of honey	Reported by	Moisture %	Glucose %	Levulose %	Sucrose %	Ash %	Acidity as formic acid
Clover (May 1943 crop, Lyallpur, Punjab)	Agri. Chemist. Pb. (Unpublished)	20·0	32·7	37·3	4·75	0·09	..
U.S.A. (average of 92 samples)	Browne (1908), U.S.D.A. Bur. Chem. Bull. 110	17·7	34·02	40·50	1·9	0·18	..
California (average of 106 samples)	Eckert & Allinger (1939), Univ. Calif. Agri Expt. Sta. Bull. 631	16·5	34·54	40·41	2·53	0·21	..
English	—	18·48	74·43		1·52	0·15	..
Belgaum	Daji & Kibe (1940), Ind. Bee Jour. **2**: 62	22·94	27·15	39·77	3·22	0·83	0·25
Maximum permissible under U.S.A. Pure Food Law		25·00			8·00	0·25	..
Tentative standards suggested for India by the Central Agril. Marketing Directorate		22·00			5·00	0·5 0·75	..
Honeydew Honey (Madras)	Ramachandran (1952), Bee-keeping in South India	15·58	66·53		6·51	1·2	..

country and abroad. It has been shown that it helps to build haemoglobin of the blood. As it provides energy in a readily available form, honey is largely taken by athletes after hard excercise or long races to regain lost energy. The tired or overworked can recover by drinking an ounce of honey in a glass of water, warm in winter, cold in summer.

In an average Indian home, honey may be used in tea, coffee, milk or buttermilk in place of sugar. The drink to which honey is added acquires an attractive and delicate flavour. Honey and curds, and honey and butter on a chapati, toast or biscuit has a delicious taste. A honey-lemon *sherbet* can be prepared by adding an ounce of honey and a piece of lemon in a tumbler of iced water in summer or warm water in winter. Honey-lemon tea is made by adding two tea-spoonfuls of honey in a cup of hot tea, flavoured with lemon instead of milk. Iced tea can be used in summer in place of hot tea.

Honey when used in baking bread, cakes and biscuits improves their flavour and enhances their keeping quality by retarding their drying up because it is hygroscopic and absorbs and retains moisture. Thus it enables a housewife to do her baking well in advance of her parties*. It can be used on fruits, cereals, in salad dressings, canning and preserving and for flavouring meats and vegetables.

Honey as Medicine. Just as lactose is used as the 'carrier' of almost all homoeopathic medicines, similarly honey is put to the same use in the Ayurvedic and Unani systems of medicine. It is a measure of the housewife's belief in its efficacy that countless home remedies and nostrums have honey in them. Some of the tested uses of honey are as: a laxative, a blood purifier, a preventive against cold, coughs and fever and a curative for sores, eyes, for ulcers of the tongue, sore throat and burns. Its regular use is recommended in severe cases of malnutrition with heart attack, impaired digestion and stomach and intestinal ulcers. Under certain circumstances it has proved useful to diabetic and allergic patients. Honey is potentially alkaline in the same way as fruits and does not produce acidosis or flatulence.

The germs of typhoid fever, dysentery, etc. die when introduced

*Detailed recipes using honey in Indian dishes have not been worked out. Those interested in Western type of cooking may contact the American Honey Institute, Madison, Wisconsin, U.S.A. for tested recipes.

Fig. 75. Honeybees gathering food from an apple blossom (Teale)

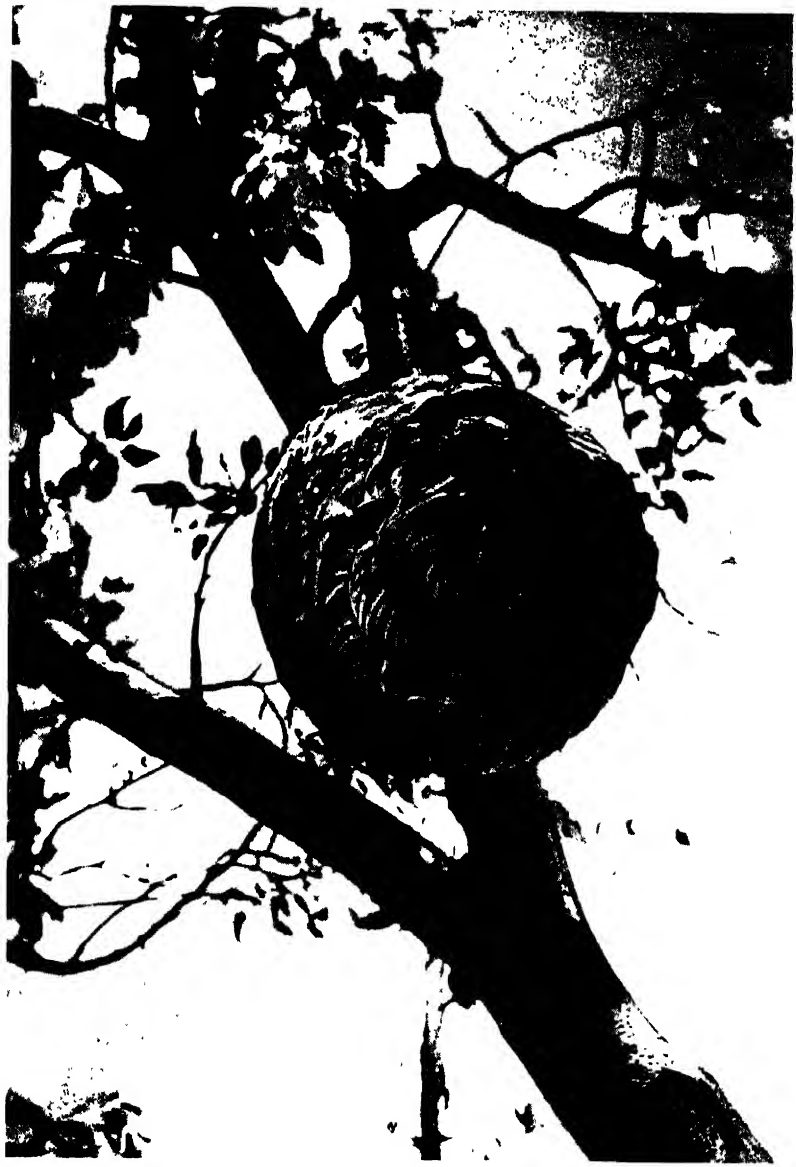


Fig. 76. Paper nest of a colony of golden wasps, *Vespa auraria* (Smith)

Fig. 77. An improvised solar wax extractor

Fig. 78. Meta-thoracic leg of a worker honeybee with a load of pollen in the pollen basket (Kelsey)

into honey. In fact, it is considered to be about the safest food from the sanitary point of view in marked contrast to milk which is an 'ideal' medium for the propagation of disease germs.

At Religious Ceremonies. Honey has an honoured place in various religions of the world. It is necessary at sacrifices and *pujas* by Hindus and is also given as the first feed to the newborn for its purification. Jews use it in preparing special cakes during certain religious festivals. Catholics prepare mead from honey for a similar purpose. The Quran has a special chapter on honey and its uses.

Odd Uses. In India which does not produce enough honey even for religious and medicinal purposes the varied uses to which honey is put in the West seem a little odd. Large quantities of honey go into the making of alcoholic drinks, mead and wine; skin and beauty lotions; for stimulating milk yield of dairy cows; for increasing the stamina of race horses; for fattening steers, poultry and fish; for curing smoking-pipe bowls and as an ingredient of cigarette and chewing tobacco to improve its flavour and texture and keep it moist. Chewing-gum owes its sweet taste to honey. It is also good for curing ham. It has been used in the shock absorbers of the cars and as the centre of golf balls. In the laboratory, honey has been found to stimulate plant growth and helps the rooting of cuttings. It prevents eggs put in cold storage from becoming gummy. Honey also plays an important part in the preparation of bacterial cultures and in the inoculation of seeds of clovers, etc. and is used with good results in poison baits for fruit flies, etc.

Storage Suggestions. Honey darkens in colour, granulates and ferments in storage. To check discolouration it should be placed in a cool (70°F) dry place because heat tends to darken it due to chemical reaction between the break-down products of the unstable levulose, and the amino-acids of the proteins and tannates with iron salts. Besides, acidic honey acts on the metallic covers of the containers and produces dark substances.

The glucose in honey crystallises at low temperatures and initially gives a cloudy appearance to the fluid which eventually solidifies into one mass. Crystallisation is accelerated by the presence of minute air bubbles, colloids, seed crystals, pollen and dust particles. If honey is heated at 160°F for 30 minutes, the air bubbles

disappear and the crystals are dissolved. Then fine straining will remove large particles. Heated honey does not normally crystallise, but in long storage and under severe cold conditions rather big crystals are formed at the bottom of the container and the rest of the honey remains fluid. Hence storage in a cool and dry place is suggested.

Certain sugar-tolerant yeasts are present in the air, hives, flowers and soil with which the bees come in contact and, therefore, honey gets contaminated with them. In ripe honey, these yeasts are not able to grow because of the high sugar concentration. Unripe honey (with more than 20 per cent moisture), however, provides favourable medium for such yeasts and their action on glucose and levulose results in the formation of alcohol, carbon dioxide and eventually acetic acid and water. Such fermentation results in acidity and honey becomes sour and has a foamy layer on top. On granulation even ripe honey also is liable to ferment as glucose can have 9 per cent moisture only and the excess moisture yielded by it during crystallisation thins down the remaining levulose in which it becomes possible for the sugar-tolerant yeasts to grow. To prevent fermentation, only ripe honey with less than 20 per cent moisture and heated to 160°F for 30 minutes should be bottled in airtight containers while still warm.*

Purity Standards. There is no rough-and-ready method to test the purity of honey by a customer. The best thing to do is to obtain supplies from a good beekeeper or a reputable concern. The popular notions that honey is not eaten by dogs and that it does not burn readily have no scientific basis. Much reliance can also not be placed on the pieces of combs dipped in honey at the bottom of the container, a device too often employed by nomads to make thick sugar syrup pass for honey. However, honey combs *with capped cells* cannot be manufactured and should be trusted. Homogeneous granulation is another sign of purity. A gallon of honey should weigh 14.1 lb. or over. Liquid honey should be clean and free from cloudiness, foreign matter such as wax, propolis, parts of bees,

*Unripe honey from frames with uncapped cells should not be extracted. If, however, some thin unripe honey is on the beekeeper's hands, it should be heated to 140°F and maintained there for not more than one and a half hour until the excess moisture has evaporated. Such heating also kills the yeasts and dissolves the glucose crystals.

or dirt (strained through a cloth with 86 meshes per inch at 130°F). All blossom honeys are levo-rotatory* that is, they deflect a beam of polarised light to the left in the polarimeter. The presence of commercial invert sugar in honey can be detected by the resorcinol or aniline chloride tests in a laboratory.

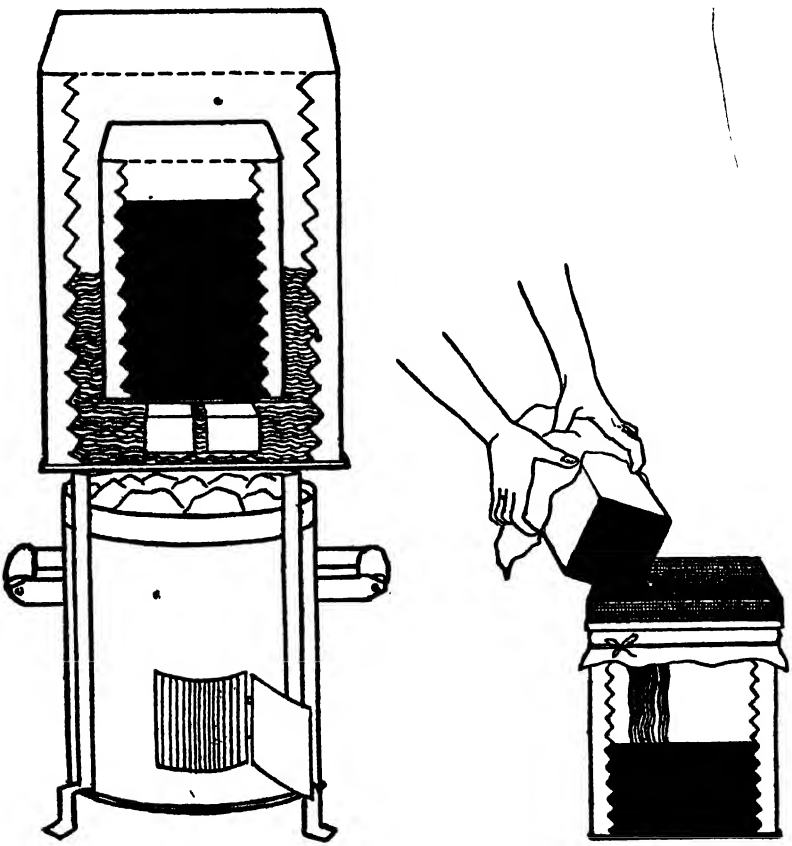
Refining Process. At the present stage when beekeeping in India cannot meet fully the demand for honey, recourse has to be taken to refine honey from the combs of *Apis indica*, *Apis dorsata* or *Apis florea* bees.** Crude honey available in the bazar which contains such impurities as wax, pollen, parts of the bees, cocoons, dirt, etc. has also to be made more presentable. Only well-capped white combs should be taken, cut into pieces with a knife and placed in the wire guaze basket (Fig. 79) of the strainer which is placed in a warm room (90°F). The honey strains through the wire gauze, cheese cloth and voil by sheer gravitation and collects at the bottom. Pieces of comb should be stirred occasionally. Straining is a slow process (three to six hours) and should be done either in a bee-proof room or at night. The strained honey should be allowed to settle so that air bubbles which get entrapped while the honey falls to the bottom of the container may rise to the surface. This scum should be removed with a knife before the honey is bottled. The left-over pieces of comb should be heated in the manner described below to extract the last drops of honey.

A simple outfit for heating honey can be improvised by cutting the tops of a one-gallon and a four-gallon hydrogenated oil empties. The smaller tin which contains the honey to be heated is placed in the bigger tin with water so that their bottoms do not touch (Fig. 79). The water is heated on a stove. Honey is stirred continuously and its temperature not allowed to rise above 120°F. If no thermometer is available, heating should be stopped when the honey becomes thin and it is uncomfortably hot. Overheating

*Certain plant sucking insects, namely, aphids and coccids excrete a sweet fluid called honeydew which is collected and stored by bees in their comb. Honeydew honey is dextro-rotatory and not much produced in this country. According to the definition of honey given in the beginning of this Chapter, such material is not considered honey.

**Pieces of honey comb can be placed in the wire gauze cage of the honey extractor after it has been provided with a bottom. The honey flows out of the combs under the influence of the centrifugal force and the process takes about 10-15 minutes in each case. It can then be strained, allowed to settle and bottled.

even in the water damages the aroma, flavour and colour of honey. Besides beeswax in the honey melts at 140°F to 145°F and clogs the strainer. The heated honey should be passed through the strainer, allowed to settle and bottled.



(a) (b)

Fig. 79. Refining crude honey; (a) heating honey in a water bath, (b) straining honey through wire gauze and double thickness of cheese cloth.

Marketing Methods. The beekeeper should try to develop a local market for his goods. A road-side stand on a well-travelled road near the apiary would sell a major share of its output. House-to-house peddling by the beekeeper himself during the slack season

builds up personal contacts and increases sales. Ripened, properly strained and bottled honey should be offered in tall narrow glass jars if it is dark and in short squat ones if it is light-coloured. One and half-pound jars should be packed and suitably labelled. Five-pound lever lid tin containers are also very convenient and cut the cost per pound in addition to the advantage of safely carrying them over long distances. One-gallon and four-gallon tins with wide openings and lever lids may also be packed. It is urged that standard brand new containers should always be used and the label should indicate (*a*) contents, (*b*) net weight, (*c*) colour grade (when in opaque containers), (*d*) floral source (if possible), and (*e*) name and address of the producer or the packer, as the case may be. Only liquid honey should be packed in glass containers, tin containers being preferred for granulated product.

Indian beekeepers have a great opportunity of developing mail-order trade. Only well-sealed tin containers packed in wooden boxes should be sent by post or rail. One broken or leaking tin is liable to ruin one's reputation built over a long time. Standard eight-gallon dairy cans suitably locked can also be used for transit by rail with an arrangement for return of empties. A lucrative local market in cut comb (chunk) honey can also be developed.

Cooperative marketing has proved a great success in Coorg and the Coorg Honey and Wax Producers' Society, Virajpet, should serve as a model for those who want to try this method of marketing. About 8,000 producers from 130 villages have combined to put up a honey and beeswax processing plant at Virajpet and market over 36,000 lb. of honey annually throughout India in attractive, properly labelled containers. The Society supplies beehives, comb foundation, etc. and lends the services of its bee instructors to members.

Beeswax. It is an important byproduct of the beekeeping industry. It is produced from honey combs, old combs, cappings collected during the extraction of honey and odd bits of burr and brace combs. The output of beeswax in a modern apiary is not much as honey combs are not crushed but are used again and again. In India the main sources are the combs of wild bees, particularly of *Apis dorsata*, from which several lakh pounds are produced annually.

Beeswax is a yellowish to grey brown solid and has an agreeable

Table 7. ANALYSES OF INDIAN BEESWAXES

Source	Description	Average					
		Specific gravity at 23°C	Melting point °C	Acid value	Ether value	Sponification Value	Iodine Value
Hooper (1904)	*Apis indica* Six samples	..	63·5	6·8	89·6	96·2	7·4
Agricultural Chemist, Punjab, (1939)	Three samples	·956	65·27	1·6	..	88·7	10·5
Hooper (1904)	*Apis dorsata* 22 samples	..	63·1	7·0	89·4	96·2	6·7
Agril. Chemist, Pb., (1939)	1 sample	·953	65·2	1·28	..	90·5	10·55
Hooper (1904)	*Apis florea* 5 samples	..	64·2	7·5	95·6	103·2	8·0
Agril. Chemist, Pb., (1939)	1 sample	·944	64·8	0·81	..	87·3	12·0
Hooper (1904)	*Trigona* sp. 8 Samples	..	70·5	20·5	89·6	110·4	42·2

honey-like odour. It is somewhat brittle when cold and when broken presents a dull, granular, non-crystalline fracture. It becomes plastic by the heat of hand. It is insoluble in water but completely soluble in ether, chloroform and in fixed and volatile oils. Its melting point varies from 63° to 65°C and is higher than all paraffin waxes. Vegetable waxes (Carnauba and Chinese) have much higher melting points. Chemically beeswax consists of a mixture of cerotic acid and myrican (myricyle palmitate).

Properties of different varieties of Indian beeswax as worked out by Hooper* and the Agricultural Chemist, Punjab (unpublished) are given in Table 7.

Many Uses. Beeswax is used in the manufacture of more than 300 items. The largest consumer is the cosmetics industry closely followed by the Catholic Church which needs it for candles, and beekeepers for comb foundation. Beeswax goes into the making of face creams (cold, cleansing, actors', camouflage, etc.), ointments, lotions, lipsticks, pomades, rouges, polishes for boots, furniture and floor, harness oils, lubricants, electric insulating apparatus, dentist's accessories, pharmaceutical preparations, modelling and plastic works, waterproofing compounds, protective coatings, different kinds of inks and waxes (ski, sealing, grafting, etc.), paints and varnishes, etc. The total quantity used in any year depends upon its availability and cost. Carnauba and Chinese waxes and resins offer continuous competition.

Rendering Process. Every apiary should have a solar wax extractor. An improvised one is shown in Fig. 77. It consists of an empty tin whose one side has been replaced by a glass pane. In it a piece of wire gauze is held over supports. Odd pieces of comb (old combs, burr and brace combs), wax-moth infested combs, dead brood combs from a transferred colony etc. are placed on the wire gauze. The extractor is kept in the sun and the heat melts the wax, which is strained to the bottom of the tin. The extractor should be bee-proof and cleaned every few days. Such an extractor is a very handy tool, and saves considerable quantity of beeswax in addition to checking wax-moth infestation and robbing among bees.

*Hooper, D. (1904) Agricultural Ledger, 1904 (7): 73-110.

Larger quantities of combs, however, should be boiled in sufficient water in a suitable container. When all the wax has melted, the mixture should be passed through a wire gauze strainer. To recover the last quantities of beeswax boiling water should be added and the mass again stirred. A jet of steam played upon this mass gives better results. The vessel containing the strained mixture of beeswax, water and finer impurities should be kept in a comparatively warm place to cool slowly. The lighter impurities will rise to the surface and the heavier will settle to the bottom. Dirt, etc. will be found at the bottom of the container. In due course, the cake of beeswax can be removed and the impurities below and above it scraped off with a sharp knife. This cake may be re-melted in water for further refining.

Wax presses, using hot water or steam designed according to special requirements of beekeepers may be locally manufactured.

Direct heating darkens the colour of beeswax and should be resorted to sparingly. Light coloured beeswax is extracted from cappings. Yellow beeswax may be bleached by breaking it into small pieces and exposing them to the sun's rays for several days. Water should be sprayed over it during the hot period of the day so that it does not melt into one mass.

CHAPTER 12

A POLLINATING AGENT

REPRODUCTION in the vegetation world may be asexual, by the formation of buds, bulbs and tubers or sexual that is through seeds. Flowers are specialised organs responsible for the production of seeds. A flower is a composite structure. Its outermost whorl is formed by the usually green sepals which protect its inner components in the early stages. Next come the petals, the brightly coloured parts specially of the ornamental flowers. They are followed by stamens (containing male cells—pollen) and carpels (containing female cells—ovules). The nectaries, glands which secrete sweet fluids, are generally located at the base of the petals. Collectively the sepals are called calyx; the petals, corolla; the stamens, androecium; the carpels, gynaecium; several fused ovaries, pistil; and the flowers, inflorescence. Various parts of a typical flower are illustrated in Fig. 80 and apple flowers in Fig. 81.

So that an ovule may develop into a seed, it is necessary that the contents of pollen should unite with it. The deposition of pollen on the stigma (receptive part of the carpel) of the same species is termed pollination and the union of the pollen with the ovule is termed fertilization.

Flowers of some plants contain both the essential organs, namely, stamens and carpels and are called perfect, bisexual or hermaphrodite. If the flowers are unisexual and contain only stamens or carpels they are termed staminate or carpellate (pistillate) flowers respectively. If both types of unisexual flowers are borne on the same plant, it is called monoecious and if on different plants dioecious.

When a flower uses its own pollen grains to pollinate its own stigma, it is called self-pollination. Cross-pollination, on the other hand, is the conveyance of pollen to the stigma of another flower on the same plant or different plant. In fruit culture, however, self-pollination refers to the transfer of pollen from the anthers of a flower of one variety to the stigma of a flower of the same variety and cross-pollination to the transfer of pollen from a flower

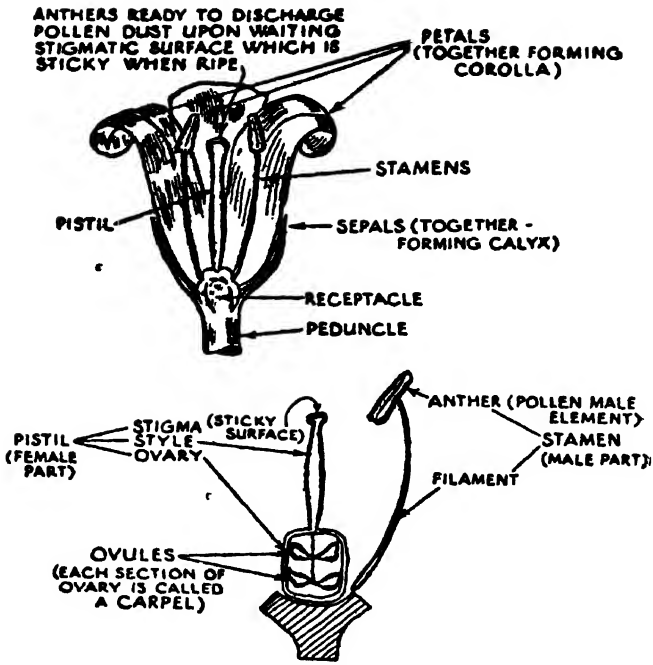


Fig. 80. Parts of a typical flower (Diagrammatic)

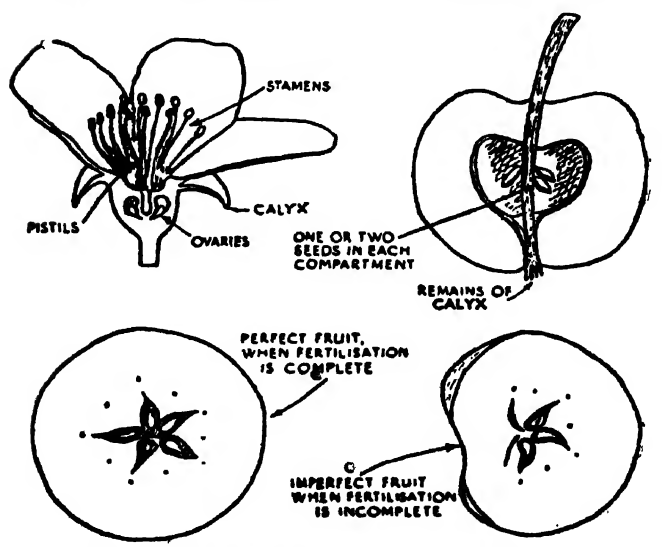


Fig. 81. Parts of an apple flower and fruit

of one variety to a flower of a different variety of the same fruit species.

Self-pollination is met with in such plants as wheat. In many species it is, however, avoided in various ways so that cross-fertilization is the rule in the plant kingdom. Most commonly the stamens and carpels ripen at different times when present in bisexual flowers or are present in unisexual flowers on monoecious or dioecious plants. When pollen from a flower may be physiologically incapable of effecting self-pollination it is called self-unfruitful (self-sterile or self-incompatible). The self-fertile or self-compatible pollen is also called self-fruitful. A pollen-yielding plant (pollinizer) that can produce a commercial crop of another variety is termed cross-fruitful, cross-compatible or cross-fertile and if it is unable to do so, it is called cross-unfruitful, inter-sterile or cross-incompatible. Cross-pollinated flowers may either be wind pollinated (anemophilous), insect pollinated (entomophilous), animal pollinated, water pollinated or they may be pollinated by gravity. The first two forms are more common. Anemophilous flowers which produce an abundance of pollen to allow for the enormous wastage, are relatively simple, inconspicuous, dull in colour and their pollen is readily liberated. Maize is a common example. On the other hand, entomophilous flowers are brightly coloured, showy, large, odoriferous and produce nectar. Generally, pollen grains liberated by them are sticky and cannot be carried away by wind. Insects visit such flowers for food-sweet nectar and protenaceous pollen. Nature made them showy and gave them characteristic odours to enable them to attract pollinating agents. They are so constructed that while insects are collecting nectar, pollen grains get entangled in the numerous plumose hair on their bodies or the flowers bring into play a certain phenomena for the liberation of pollen on to their bodies or on the stigma. The insects, during their visits to other blossoms, drop pollen grains on their stigmas and thus help cross-fertilization. Some insects-solitary and social bees, take the pollen home to serve as protenaceous (like meat) food for their young (Fig. 78). It has been shown that the bodies of pollinating insects have been evolved for the special purpose of visiting certain flowers and the flowers are correlated with the shape and habits of insects that visit them, their beautiful colours and pleasant odours serving as attractions.

Well over a thousand blossom-visiting species of insects are known. Though most of these go to blossoms for nectar and pollen, quite a number are there either to suck the juices of the plant, eat its tissue, lay eggs in the blossoms or prey upon foraging insects. The former group is really important from the pollinating point of view. The latter's contribution is not big. To this class belong such insects as earwigs, grasshoppers, mantids, bugs, aphids, aphid-lions, ant-lions, thrips, beetles and various kinds of wasps, etc. Butterflies, moths, two-winged flies and social and solitary bees belong to the former class.

Butterflies and moths have admirably adapted themselves to flowers. Biological literature is replete with the details of various arrangements made by nature in wild and ornamental blossoms to make them suitable for pollination by various species of butterflies and moths. Unfortunately, moths and butterflies are not fond of fruit blossoms or flowers of commercial crops. Flower flies, flesh flies and bee flies are better in this respect. *Blastophaga* wasps are essential for the caprification (cross-fertilization) of figs. Among the solitary bees, the mining bees (*Andrena* and *Halictus*), the carpenter bees and the leaf-cutting bees are good pollinators. *Andrena* and *Halictus* rival honeybees in efficiency and steadfastness and are responsible for the pollination of blossoms in certain localities. Bumblebees, stingless bees and honeybees are the three kinds of social bees available in India. Bumblebees live in the Himalayas at 5,000 feet or more above sea level and stingless bees in South India. Only preliminary work has been undertaken to study the pollinating habits of the three species of honeybees in India, but it is surmised that they are similar to their European relations in this respect. The latter have been studied in detail in many parts of the world.

POLLINATOR'S QUALIFICATIONS

Constancy. The insect should show 'flower fidelity', that is, it must restrict itself to the blossoms of plants of one species at a time so that pollen grains left by it during its visits on the stigmas of the flowers may fertilize the ovules. Insects which flit from flowers of one plant species to those of another will cause little fertilization.

However, too much specialisation may limit the usefulness of the insect.

Thoroughness. The visitors should work their way into the flowers so that they come into touch with the essential organs, namely, anthers of stamens and stigmas of carpels (Fig. 80.) Otherwise they will not be able to transfer pollen from one flower to the other. If they take both nectar and pollen for food, they will be more effective as compared to those who visit the blossoms for nectar only. The contact of the latter class of insects with pollen grains is accidental and no sure results can be expected.

Working Hours. Those visitors which start their work early in the day and continue late in the evening naturally put in more work quantitatively. Further, those visitors which work for comparatively long periods during inclement weather such as cloudy and cold days will be beneficial to those crops which put forth blossoms under such conditions.

Total Population. It would be highly desirable to have big population of pollinating insects at the blossoming time of a crop so that a maximum yield of the crop is obtained and the number of insects available at the time does not act as a limiting factor. If the pollinators and their placement is under the control of man, it would be an added advantage.

Though certain species of insects have adapted to pollination of certain crops on a commercial scale, namely, *Blastophaga* spp. to figs or flesh flies—*Phorima* and *Lucilia* to onions in breeding cages, most insects are general pollinators. Table 8 lists the qualities of these insects in the light of the above observations. It should be clear that honeybees are the most constant and faithful friends of flowers rivalled by mining bees and followed by bumblebees and flower flies. They are thorough workers though bumblebees and flies may bring about more cross-pollination with their haphazard methods. Honeybees are surpassed by bumblebees and flies in hours of work but are better than solitary bees in the daily amount of work in all kinds of weather. The populations of insects vary from locality to locality but honeybees number more than others. Moreover, hive bees (*Apis indica* or *Apis mellifera*) can be moved into any desired area and their population adjusted to the needs of a particular crop.

Table 8. Characteristics of Some Important Insect Pollinator Groups

INSECT GROUP	CHARACTERISTICS			
	CONSTANCY	THOROUGHNESS OF WORK	WORKING HOURS	POPULATION
1	2	3	4	5
I. Two-winged flies				
(*i*) Flower flies	If they continue to obtain food, they work blossoms of one species and also restrict their activities to small areas, otherwise haphazard work.	Flit about quickly; pollen distribution accidental to their visits for nectar; do not collect pollen.	Inactive at cold temperatures, high wind velocity and dim light; they have no nest to go to, stay in the field and start work when conditions permit; working hours longer than those of solitary bees.	Distribution very much localised as population depends upon availability of breeding materials such as polluted waters, insect and plant hosts, etc.
(*ii*) Flesh flies	Haphazard work.	do	do	Breed in decaying flesh and parasitise on animals; hence high population under unhygienic conditions. Maggots parasitic on various stages of other insects.

1	2	3	4	5
(*iii*) Bee flies	do	do	do	Maggots parasitic on various stages of other insects.
II. Solitary wasps				
(*i*) *Blastophaga*	Breed in caprifigs but female wasps visit other kinds of figs also. Visit figs only and are highly specific.	They are the only insects which can pollinate figs.	Not known	They can be bred artificially in laboratories and the population can be controlled.
III. Solitary bees				
(*i*) Mining bees	Rival the honeybees in constancy.	Rival the honeybees in efficiency.	Working hours short, they are warm weather visitors, do not stir out on cold, cloudy and windy days.	Nests found in wastelands but with the spread of agriculture and clean cultivation, their population is getting reduced in various localities; cannot be artificially bred.
(*ii*) Carpenter bees	Flower fidelity lower than social bees and mining bees.	Flit about quickly; collect pollen in scopa; considered good cross-pollinators.	do	Build holes in timber to serve as nests, hence considered pests; population very variable, cannot be bred artificially.

Table 8—*Contd.*

INSECT GROUP	CHARACTERISTICS			
	CONSTANCY	THOROUGHNESS OF WORK	WORKING HOURS	POPULATION
1	2	3	4	5
(*iii*) Leaf-cutting bees	Flower fidelity lower than social bees and mining bees.	Flit about quickly; collect pollen in scopa; considered good cross-pollinators.	Working hours short, they are warm weather visitors, do not stir out on cold, cloudy and windy days.	Build cells in soil or specially formed mud-cells in various types of cavities, population very variable and cannot be bred artificially; a nuisance in residences.
IV. Social bees (*i*) Bumblebees	One out of three pollen loads are mixed in their case as compared to 3% mixed loads in honeybees (*A. mellifera*)	Quick workers and their haphazard work is an advantage in cross-pollination; some times nectar-robbers (cut holes, do not come into contact with anthers); such visits are useless from the point of view of pollination.	Work longer hours and under severer climatic conditions	Distribution in India restricted to higher hills; population in spring restricted to queens only, hence their utility as pollinators of blossoms of deciduous fruit trees limited; cannot be bred atrificially.
(*ii*) Stingless bees	Little information available about their pollination qualities but habits, in general, assumed to be comparable to honeybees.			Not domesticated in India; population in nature variable and cannot be depended upon.

Table 8—*Concluded*

1	2	3	4	5
(*iii*) True honeybees (*a*) *Apis dorsata*	Assumed to be as constant as the European bees.	Assumed to be as thorough as the European bees.	These bees are known to have longer working hours than the *Apis indica* bees.	Population variable; cannot be domesticated; see p. 32 regarding distribution.
(*b*) *Apis florea*	do	do	During winter have shorter working hours than *Apis dorsata* and *Apis indica*.	Ditto, see p. 37 re: distribution.
(*c*) *Apis indica*	do	do	They start work early in the morning and stop work late at dusk if light, temperature and wind conditions are favourable. Do not work during the noon hours in summer.	Population variable in various localities but can be increased at will by man with modern beekeeping methods.
(*d*) *Apis mellifera*	Very faithful to a crop and an area; get localized to small areas and continue to work on the same plant and field throughout life as long as the blossoms continue.	Thorough workers and pollinators.	Have long working hours (depending upon the crop they are working on at the time).	This species has not so far been established in India, see p. 41

COMMERCIAL CROPS

The following is the list of major fruits, vegetables, oilseeds and fodder crops that require cross-pollination and greatly benefitted by insect visits.

Fruits. Almond, apple, apricot, avocado, black and raspberries, blue and huckleberries, cherry, citrus, cocoanut, cranberry, figs, gooseberry, grapes, mango, peach, and nectrines, pear, persimmon, plum and prune, strawberry, etc.

Vegetables. Asparagus, broccoli, brussel's sprout, cabbage, cauliflower, carrots, collards, coriander, cucumber, fennel, kale, kohl rabi, lotus, melon, onion, pepper, pumpkin, radish, rape, rutabaga, squash, turnip, watermelon, etc.

Oilseeds. Mustard, rape, *raya* (*Brassica juncea*) *toria* (*Brassica napus* var. *toria*), sesamum, etc.

Fodders. Clovers (alsike, crimson, Egyptian, ladio, Persian, red, strawberry, white), lucerne, *raya*, sunflower, trefoil, vetch, etc.

Special pollination needs of temperate-zone fruits require special treatment. Though all these plants require cross-pollination for the proper formation (size and shape), development of colour and proper yield, there are some fruits like apples, sweet cherries, pears and some varieties of peaches, plums and prunes, strawberries and grapes which are self-unfruitful. In their case cross-pollination (in the horticultural sense) is required with cross-fruitful varieties.

Almond. All common varieties, namely, Texas, Drake, I.X.L., Ne Plus Ultra, Non-Pareil, etc; are self-unfruitful and provision of cross-fruitful varieties is essential.

Apple. Of the common varieties grown in India, Cox's orange pippen, Beauty of Bath, Fameuse, Gravenstein, McIntosh, Yellow Bellflower, R. I. Greening, Wine-sap, Northern Spy and Delicious varieties are self-unfruitful and Jonathan, Yellow Newtown, Black Ben Davis, Rome Beauty, Brameleys seedling and Worcester's Pearman are very slightly self-fruitful and may be considered as practically self-unfruitful. Cross-fruitful varieties will be necessary in the plantings of the above varieties.

Sweet Cherries. Napolean, Black Tartarian, Roundel, Elton, Bing, Early Richmond, Morello and Black Biggarean are commonly

grown in India and are self-unfruitful and it is necessary to grow cross-fruitful varieties in their blocks.

Peaches. Only J. H. Hale, Red bird cling, Salway and St. John varieties grown in India are self-unfruitful and require cross-fruitful varieties.

Pears. Most of the pear varieties are self-unfruitful and require to be intermingled with other varieties. Of the common pears grown in India, William Bartlett, Clapps Favourite, Beaurre d' Anjou, Conference, Beaurre Bosc, Beaurre Hardy, Winter Nelis, Flemish Beauty and Seckel are self-unfruitful. Information regarding other common varieties, namely, Doyenne Dette, Doyenne Decomice, Burnum, Jeiasui, Napolean, Josephine, Easter Beaurre, Ded Melinis, Windsor and Duchess is not available. However, it may be stated that all varieties of the European pear (*Pyrus communis*) and those of hybrid origin such as Keiffer (*P. communis* × P. *serotina*) have been found to be self-unfruitful. Moreover, varieties which are closely related are cross-incompatible.

Strawberries. The perfect (hermaphrodite) flowered varieties are self-fruitful but often they produce only pistillate flowers or environmental conditions reduce the viability of their pollen. Other varieties are imperfect (pistillate flowers only) and require pollinizing variety plants in their fields.

Grapes. There are hermaphrodite, pistillate and staminate as well as self-unfruitful varieties among grapes. Except the seedless varieties, which belong to the staminate group provision of staminate variety plants in every third row is recommended.

It has been noticed that plants grown from cross-pollinated seeds generally have greater vigour, weight and height and produce flowers earlier than those that result from self-pollination.

HONEYBEES IN ORCHARDS

As pointed out already, honeybees in hives (*Apis indica* or *Apis mellifera*) are the only insects whose population can be increased in an area by bringing in colonies from another area at the blooming time of a particular fruit, vegetable, oilseed or fodder crop. In localities where there are no large areas of wasteland around orchards and fields and where clean cultivation is practised with consequent low population of wild pollinating insects, fruit growers

and farmers will be well advised to bring in colonies of honeybees. As a general rule a strong colony* of *Apis mellifera* bees and two colonies of *Apis indica* bees to the acre will suffice. For crops like lucerne with difficult pollination problems, the number of colonies per acre should be twice the normal. Colonies should be brought into the orchard or fields just before the flowers are to open, otherwise a major portion of the field force of the bee colonies may get localized to other crops or other areas. It is better to spread the colonies around the orchard or fields in groups of two or three instead of locating several dozens at one place. In this case such of the foraging bees of strong colonies as are localized to nearby areas will take advantage of short spells of bright weather during inclement weather and will visit the blossoms. The spraying of trees or crops with inorganic or modern synthetic pesticides during the blooming period should be avoided. If, however, there is no other way to control harmful insects, application of insecticides etc. should be resorted to between 7 P.M. and 7 A.M. and restricted to materials which are comparatively safe for bees when used in proper strengths. Some of the newer materials which are relatively safe for bees are toxaphene and methoxychlor.

The renting of bee colonies by fruit growers and farmers from beekeepers at the blossoming time of crops is a common practice in Western countries particularly in the U.S.A. where rentals go as high as $ 5.00 to $ 10.00 (Rs. 25/- to 50/-) per colony per crop. At the present stage of development of beekeeping in India renting of bee colonies in most localities may not be possible and horticulturists and farmers themselves will have to undertake beekeeping, not so much for honey as for pollination.

In most localities which are deficient in insect populations, the placing of bee colonies in orchards, fields of vegetables, oilseeds and fodders grown for seed has increased the yields. An increase of 10 to 25 per cent is a very common experience. Money spent on renting bees or establishing a modern apiary will be fully repaid in the form of bigger and better crops.

*Colonies with three to five frames of capped brood and bees covering six to eight frames in early spring are considered strong. Even half a dozen weak colonies may not be able to put forth as large a field force as one strong colony.

APPENDIX

GENERAL INFORMATION

A person desirous of taking up beekeeping wishes to find out as to wherefrom he can get information on bees and bee equipment. Information on some of the important items is given below:

I. BEEKEEPING ORGANISATIONS

INDIAN

1. All India Beekeepers' Association, P.O. Ramgarh, Nainital, U.P.
2. There are State Beekeepers' Associations in several States with headquarters at the capital city of the State concerned.

FOREIGN

1. National Federation of Beekeepers' Association, Atlantic, Iowa, U.S.A.
2. American Honey Institute, Madison, Wisconsin, U.S.A.
3. Canadian Beekeepers' Council, Ottawa, Canada.
4. British Beekeepers' Association, London, E.C. 4, United Kingdom.
5. Apis Club, The Ways' End, Foxton, Royston, Herts, United Kingdom.

II. BEEKEEPING PERIODICALS

INDIAN

1. Indian Bee Journal, P.O. Ramgarh, Nainital, U.P.

FOREIGN

1. Gleanings in Bee-culture, Medina, Ohio, U.S.A.
2. American Bee Journal, Hamilton, Illinois, U.S.A.
3. Bee World, Brockhill, Camberley, Surrey, England.
4. British Bee Journal, 1, Gough Square, London, E.C. 4, United Kingdom.

III. BOOKS ON BEEKEEPING

INDIAN

1. Beekeeping in South India, Supdt. Govt. Printing Press, Madras.
2. Handbook on Beekeeping, Controller of Printing and Stationery, Punjab, Chandigarh.
3. The Romance of Scientific Beekeeping by K. C. Das Gupta, Khadi Pratisthan, Calcutta.
4. Magas Bani (Urdu) by Begum M. H. Hashmi, Bhupen Apiaries, Ramgarh, U.P.
5. Shahd (Urdu) by Wajid Hussain, Shah & Co., Agra.
6. Shahd-ke-Krishme (Urdu) by Wajid Hussain, Shah & Co., Agra.

FOREIGN

1. A.B.C. and X.Y.Z. of Bee-culture by A.I. & E.R. Root, A.I. Root Co., Medina, Ohio, U.S.A.
2. Beekeeping by F.E. Phillips—MacMillan & Co., New York City.
3. The Hive and the Honeybee by R. A. Grout, Dadant & Sons, Hamilton, Illinois, U.S.A.
4. Practical Queen Rearing by F. C. Pellet, Jost and Kiefer Printing Co., Quincy, Illinois, U.S.A.
5. Bee Venom Therapy by B. F. Beck. D. Appleton Century Co., New York City.
6. Honey Production in British Isles by R.O.B. Manley, Bradley & Sons, Reading, United Kingdom.
7. Manual of Beekeeping by W. Wedmore—E. G. Taylor, London, United Kingdom.
8. Practical Bee Guide by J. G. Digges—Tabbot Press, Dublin, Eire.
9. The Golden Throng by E. W. Teale—Dodd, Mead & Co., New York City.

IV. BEE SUPPLIES

INDIAN

1. Bhupen Apiaries, P.O. Ramgarh, Nainital, U.P.
2. Coorg Honey and Wax Producers' Cooperative Society Ltd., Virajpet, Coorg, S. India.

COURSES OF TRAINING IN BEEKEEPING

State	Name and address	Duration	Fees	
1. Punjab (I)	Govt. Beefarm Katrain (Kulu)	5th September to 9th October	Punjab candidates Others	Rs. 10/- Rs. 30/-
2. ,,	,, ,, Nagrota (Kangra)	15th April to 19th May	-do-	-do-
3. ,,	Govt. Beekeeping Station, Saproon (Simla Hills)	22nd April to 26th May	-do-	-do-
4. Uttar Pradesh	Govt. Apiary, Jeolikote (Nainital)	3 months throughout the year except winter	U.P. candidates Others (Hostel accomodation free)	Rs. 15/- Rs. 45/-
5. Madhya Pradesh	Maganwadi Apiary, Wardha (M.P.)	Training specially arranged	..	
6. Bombay	(*i*) Ganesh Khind Fruit Expt. Station, Kirkee (Poona) (*ii*) Beekeeping Centre, Mahabaleshwar.	Two months (10 students only) 8 months and 4 months	Bombay—free Rs. 15/- and Rs. 10/-	
7. Madras	Y.M.C.A. Rural Reconstruction Centre, Ramathapuram, Coimbatore.	..	..	
8. ,,	Agricultural College, Coimbatore	Fifteen days (during February)	Madras—free	
9. ,,	Gandhi Ashram, Tiruchengody		..	

3. Further addresses of bee suppliers and instructions and blueprints for making hives etc. can be obtained from the Entomologists at the Agricultural Colleges of the respective States.

4. Comb foundation

(*a*) For *Apis indica* hill variety bees.

(*i*) Government Apiary, Jeolikote, Nainital, U.P.

(*ii*) Bhupen Apiaries, Ramgarh, Nainital, U.P.

(*iii*) Entomologist, Agricultural College, Ludhiana, Punjab (India).

(*b*) For *Apis indica* plains variety bees.

(*i*) Government Entomologist, Agricultural College, Coimbatore, Madras.

(*ii*) Coorg Honey and Wax Producers' Cooperative Society, Virajpet, Coorg.

V. CONTAINERS FOR HONEY

(*a*) GLASS

(*i*) Kaycee Glass Works, Shikohabad, U.P.

(*ii*) Naini Glass Works, 187, Bahadurganj, Allahabad.

(*iii*) Gwalior Glass Industries, Gwalior, M.P.

(*iv*) Mysore Glass & Enamel Works, 34, Gandhi Nagar, Bangalore City.

(*v*) Krishna Silica & Glass Works, Ltd., 17, Radha Bazar Street, Calcutta.

(*b*) TIN

Metal Box Co. of India, Calcutta.

VI. COURSES OF TRAINING IN BEEKEEPING

The Courses of training are given in the Table on page 207.

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